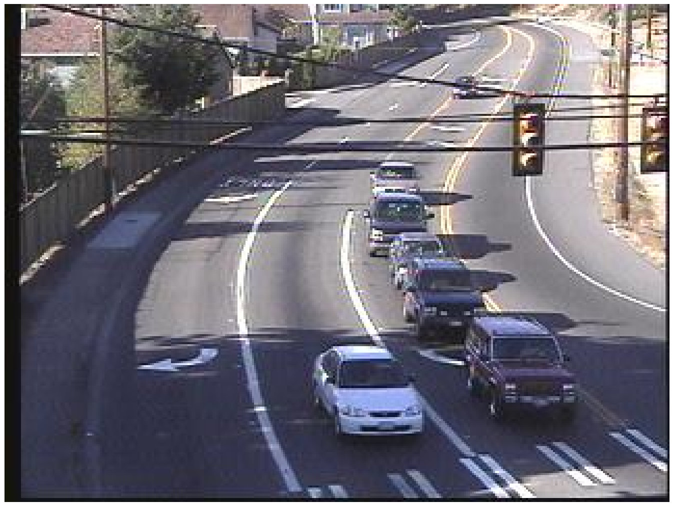
King County



2003 Annual Traffic Safety Report

Collision Information and Trends

King County Department of Transportation
Road Services Division
Traffic Engineering Section

January 31, 2005

SAFETY REPORT USER FEEDBACK

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1.0 EXECUTIVE SUMMARY

During 2003, a total of 2,692 reported vehicular collisions occurred within unincorporated King County. These included 14 fatalities and 971 injury accidents, and represent an estimated societal cost of $87 million[1].

This report reviews collision trends within unincorporated King County and the safety related programs utilized by the King County Department of Transportation (KCDOT) in the ongoing effort to reduce the number and severity of these collisions. It is intended to provide critical information that can be used to better allocate limited safety funds, increase driver awareness of safety concerns, and improve the safety of the traveling public.

This report is prepared by the Road Services Division's Traffic Engineering Section, and is an integral part of KCDOT's Safety Management System.

1.1. Ten-Year Trends

Annexations and incorporations have significantly reduced the size of unincorporated King County over the past ten years. As a result, the population, maintained road miles, and annual miles driven on county roadways have decreased.

It is necessary to account for these external factors when comparing 2003 collisions with data from previous years. To allow direct comparison, the data is "normalized" using the estimated accident rate for vehicular collisions, and using collisions per 10,000 population for pedestrian and bicycle collisions. The estimated accident rate (accidents per million vehicle miles) has fluctuated, varying between 1.10 and 1.54, with little evident trend. Pedestrian and bicycle collision rates (collisions per 10,000 population) have decreased by 17% and 51%, respectively.

Further information on trends is provided in Sections 3 and 4 of this report.

1.2. 2003 Collisions

Approximately two-thirds of the accidents in 2003 fell into one of three categories: run-off-road, rear end, or right angle collisions. Pedestrian and bicycle collisions comprised 1.4% and 1.0% of the accidents, respectively.

Run-off-road collisions were the most frequent accident type, accounting for approximately one-fourth of all collisions and seven of the fourteen fatal accidents. A total of 629 run-off-road collisions occurred during 2003, with an estimated cost of $22.1

[1] The following estimated costs per accident are used in this calculation: Property Damage Only-$6,000, Injury-$65,000, Fatality-$1,000,000

million. Two-thirds of the run-off-road collisions involved an isolated fixed object, and utility poles were the most frequently struck isolated object.

Approximately 90% of all pedestrian, bicycle, and motorcycle collisions resulted in an injury or fatality. In addition, one-half of all pedestrian collisions involved a pedestrian under age 20, and two-thirds of all bicycle collisions involved a cyclist under age 20.

Review of 2003 collision data indicates the following:

- Two-thirds of all collisions occurred during dry pavement conditions.
- 44% of collisions occurred at intersections. Rear-end, right angle, run-off-road, and left turn collisions comprise 80% of all intersection accidents.
- Nearly one-third of the non-intersection collisions were run-off-road accidents.
- Nearly one-half of the collisions occurred on roadways with steep grades, horizontal curves, or combinations of these alignments. Since these alignments are thought to comprise a much smaller percentage of King County's road system, it is likely that the accident rate at these locations may be significantly higher than at level tangent sections.
- Over 1/3 of the drivers involved in collisions were between 16 and 24 years old.
- Alcohol was involved in approximately 11% of all collisions.
- Defective equipment was discovered in vehicles in 123 collisions.

Additional 2003 collision information is contained in Sections 5 and 6 of this report.

1.3. Safety Related Projects and Programs

Safety is an integral component of all Road Services Division projects. Several projects and programs that focus on safety are discussed below:

- The Countywide Guardrail Program addresses roadside safety by focusing on locations with a high risk of run-off road collisions. The goal of this program is to reduce the frequency and severity of run-off-road collisions by improving the roadside environment. In 2003, 12,450 linear feet of guardrail was installed on eight roadway corridors. Fixed objects and other roadside hazards on these corridors were also eliminated.

- The HAL/HARS Program identifies, prioritizes, and implements safety improvements for King County's High Accident Locations (HALs) and High Accident Road Segments (HARSs). The primary goal of the program is to address safety in the most cost-efficient manner by directing limited resources at the most effective improvements. Accomplishments during 2003 include:
  - A new HAL/HARS priority list was produced based on 1998 through 2000 collision data. The list contains 48 HALs and 51 HARSs.
  - Work continued on projects on the 1996 list. This list contains 100 HALs and 50 HARSs. As of December 2003, the majority of the projects have

been completed. Twenty-three projects were in the planning, design or construction phase, one was on hold, and four were unfunded.
    - Before/After Studies were completed to assess the impact of 35 completed HAL/HARS projects. A reduction in collisions occurred at the majority of the locations. The projects eliminated 129 collisions each year, and the estimated annual cost savings associated with the reduction in accidents is approximately $1,400,000.

- When properly designed and operated, traffic signals are valuable devices for the control of vehicular and pedestrian traffic. King County currently owns and operates 133 traffic signals. In 2003, six new traffic signals were added and four locations were modified to improved safety, efficiency, and capacity.

- Many of the Road Services Division's Capital Improvement Program (CIP) projects are directly related to safety, and most of the remaining CIP projects have a safety component. Thirty-seven CIP projects were constructed in 2003, while design continued on forty-eight additional projects.

- Properly designed and maintained signs are critical to roadway safety. KCDOT owns and maintains approximately 46,000 signs. During 2003, 800 sign-related work orders were issued.

- Reported pedestrian collisions are infrequent, but receive special attention due to their severity. The Pedestrian Pathway Prioritization (3P) Program, also referred to as the Pedestrian Safety and Mobility Program, designs and constructs improvements for pedestrians and other non-motorized users. This program is managed by the Traffic Engineering Section, and funded through the CIP.

- The School Pathway Program is a collaborative effort between King County and the county's 16 public school districts and dozens of accredited private schools. Each district submits a list of potential pathway projects based on their prioritized needs. Projects are selected based on the priority rating given by the school district, cost, location, size and feasibility.

- Traffic safety investigations include speed limit studies, requests for parking prohibition, sight distance concerns, requests for illumination, intersection operational improvements, installation of signing, traffic control and flasher installation. During 2003, the Traffic Engineering Section completed approximately 640 traffic safety investigations.

- Targeted enforcement can dramatically improve safety in problem areas by reducing speeding and other illegal driving behavior, and by educating motorists on safe driving practices. The Selective Traffic Enforcement Plan (STEP) is a collaborative program bringing together the resources of two King County Departments: the Sheriff's Office and the Department of Transportation. During

2003, STEP officers issued over 2,600 warnings and 6,900 citations with a total of nearly $900,000 in fines.

- The Neighborhood Traffic Safety Program (NTSP) offers a wide range of services to address the traffic safety concerns within neighborhoods. These services include:
    - The availability of two traffic enforcement officers for speed enforcement within the residential areas.
    - Holding neighborhood meetings to discuss the causes of speeding and to provide educational messages.
    - Placement of signs emphasizing safe driving practices.
    - Use of speed trailers and radar/readerboard cars.

Section 7 contains additional information on safety-related projects and programs.

1.4. Recommendations

One of the primary goals of this Annual Safety Report is to evaluate safety efforts and make recommendations to improve these efforts. The following recommendations are made based on the information developed in this report. Further details on these recommendations are provided in Section 8 of this report.

- Given the number of utility pole collisions, adding a relocation requirement for the poles closest to the edge of the roadway should be seriously considered. King County is currently working with utility companies to revise the Utility Franchise Agreement, and discussion of such a requirement is recommended.

- The ability to review collision data in a Geographical Information System (GIS) database would provide significant benefits with respect to safety management. A review of the cost and staffing requirements to accomplish this within a one-year time frame is recommended. The information obtained in this review could then be used to determine the feasibility of a GIS conversion.

- Further efforts to reduce the severity of motorcycle collisions appear to be warranted. Such efforts could include public service announcements, additional enforcement, and discussion with State officials regarding licensing requirements and driver education.

- Education and outreach for younger drivers may be an appropriate area for additional focus. The State of Washington recently initiated graduated licensing requirements for younger drivers. Additional efforts could include public service announcements, visits to local high schools, and discussion with State officials regarding licensing requirements and driver education.

- Safety improvement projects were identified for four of the "top ten" arterials (those with the highest accident rates). Review of the remaining six arterials for possible safety improvement projects is recommended. A review of the top ten arterials on an annual basis is also recommended.

2.0 INTRODUCTION

The King County Department of Transportation (KCDOT) is pleased to present the 2003 Annual Safety Report. This report is prepared by the Road Services Division's Traffic Engineering Section, and is an integral part of KCDOT's Safety Management System.

A number of changes have been made in the format and contents of this report. While previous reports have focused on reporting accident data, this report has been expanded to include additional analysis of accident data, a summary of safety activities completed by KCDOT, assessment of the impact of safety improvement projects, and recommendations to improve safety efforts.

We hope that readers find this report informative and useful. A feedback form is provided in the front of this report for readers who would like to provide comments or suggestions.

2.1. Report Purpose

This report was prepared for several purposes, including:

- To meet the requirements of WAC 308-330-245, which requires agencies to issue an annual safety report.
- To provide collision and safety information to elected officials, King County DOT staff, and the general public.
- To highlight King County DOT's safety related programs, and policies.
- To assess the effectiveness of King County DOT's ongoing safety improvement activities.
- To increase driver awareness with respect to safety concerns.
- To provide critical information that can be used to better allocate limited safety funds.

Ultimately, the goal of this report is to improve the safety of the traveling public.

2.2. Information Sources

The majority of the collision information provided in this report comes from the King County Collision Record System (KCCRS) database, which contains information on reported collisions that occurred between 1997 and 2003. Information on collisions that occurred prior to 1997 was obtained from KCDOT's Intersection Magic® database, which contains collision data from 1984 on.

The Washington State Patrol provided collision data for accidents occurring prior to 1997. Collision data for accidents occurring between 1997 and 2003 were entered into

KCCRS database by King County DOT staff. In both cases, the information was obtained directly from collision reports prepared by the responding Officer at the scene of the collision. In order to be entered into the database, a collision must occur on a county-maintained roadway within unincorporated King County, and must meet the reporting threshold of $500 in property damage or result in an injury or fatality.

Information on state and national collision trends used for the purposes of comparison is obtained from a variety of sources, including the Washington State Highway Accident Report, National Cooperative Highway Research Program (NCHRP) Reports, Washington State's Office of Financial Management, Washington State Department of Motor Vehicles and publications of the American Association of Highway and Transportation Officials (AASHTO).

Other information used in this report is courtesy of several local agencies, including the State of Washington's Office of Financial Management for population data, the County Road Administration Board (CRAB) and the Road Services Division's Engineering Services section for roadway miles maintained by King County, and the Traffic Engineering Section for traffic count data.

Sources of information are discussed further in Appendix A.

2.2.1. Limitations of Data

A report is only as good as the data that it utilizes. For this reason it is important to be aware of the quality and limitations of the data in this report.

The two databases contain information on nearly 100,000 collisions. While significant effort is directed toward quality control, databases of this size inherently contain data entry errors. The Officer's reports may also contain errors. Despite this, the overall quality of the data is considered acceptable for the purposes of this report.

2.3.

Report Organization

This report is organized as follows:

Section One contains the Executive Summary, and this Introduction is contained in Section Two. A discussion of trends in population, land area, and traffic conditions within Unincorporated King County is provided in Section Three.

Section Four addresses ten-year collision trends, and Section Five discusses collisions by accident type. Section Six provides a breakdown of collisions according to selected categories, such as lighting conditions, road surface conditions, and circumstances contributing to the accidents.

Section Seven provides information on KCDOT's safety related projects and programs. Recommendations are offered in Section Eight.

Appendix A provides further information on data sources used in this report, while Appendix B discusses formulas used. Appendix C contains additional tables and figures that do not appear in the body of the report. Information on the Selective Traffic Enforcement Program (STEP) is included in Appendix D.

3.0 EXTERNAL FACTORS

External factors such as development activity, new roadway construction, incorporations, and annexations influence the population, traffic volumes, and the road miles within unincorporated King County. Changes in population, traffic volumes, and road miles in turn affect the frequency of collisions by increasing or decreasing exposure.[2]

It is necessary to account for these external factors when comparing 2003 collisions with data from previous years. To allow direct comparison, the data is "normalized" using population and annual miles driven. Table 1 provides a comparison of these factors for 2003, 2002 and 1994.

TABLE 1
POPULATION, ROAD MILES, & TRAFFIC VOLUMES

Category	2003	2002	1994
Population[1]	351,843	351,700	507,226
Land Area (square miles)[2]	1,751	1,752	1,830
Road Miles Maintained[3]	1,883	1,895	2,361
Average Daily Traffic Volumes on Principal Arterials[3]	13,231	13,441	11,717
Annual Miles Driven (million miles)[3]	2,244	2,295	3,273

Data Sources:
1. *King County Office of Budget - 2002 Annual Growth Report; and the State of Washington Office of Financial Management*
2. *King County Office of Budget*
3. *See Table C3 (Appendix C)*

As indicated in Table 1, unincorporated King County's population, land area, maintained road miles, and annual miles driven have decreased over the past 10 years. Land area has decreased by 4%, while population, road miles, and miles driven have decreased by 20% to 35%. These changes suggest that annexations and incorporations, which decrease road miles and miles driven, have a greater influence than development and new road construction, which tend to increase them. Annexations and incorporations have also decreased the percentage of road miles in urban areas, and therefore affect the character of King County's road system.

Traffic volumes on principal arterials have increased 13% over the past 10 years. This result is expected since principal arterials are used by motorists throughout the region, and therefore are affected by regional growth. The increase in volume on these roadways is of concern due to their importance to regional mobility.

[2] The term exposure refers to the risk of collisions due to the presence of vehicles on the road. Exposure increases as the number of vehicles on a roadway and the length of a roadway increases. For example, given two similar roadways with different lengths, more collisions would be expected to occur on the longer roadway.

4.0 COLLISION TRENDS

In evaluating collision data, it is important to review historical trends. This section discusses collision trends over the past ten years. Data is addressed in terms of number of collisions and is also normalized to account for changes in population and roadway use within unincorporated King County. Trends in pedestrian, bicycle, and motorcycle collisions are also discussed.

4.1. Overall Trends

A total of 2,692 collisions were reported in unincorporated King County in 2003.

It is necessary to account for external factors when comparing 2003 collisions with data from previous years. To allow direct comparison, the data is "normalized" using the estimated accident rate. The estimated accident rate (accidents per million vehicle miles) has fluctuated, varying between 1.10 and 1.54, with little evident trend.

Review of collision trends indicates the following additional changes over the past ten years:

- Annual collisions have decreased by 41%.
- The estimated annual societal cost of these collisions has decreased by 49%.
- Pedestrian and bicycle collisions have decreased by 43% and 66%, respectively.
- Pedestrian and bicycle collision rates (collisions per 10,000 people) have decreased by 17% and 51%, respectively.
- Motorcycle collisions have decreased by 10% over the past ten years, but have increased by 44% since 1999.

With the exception of the estimated accident rate, a decreasing trend is apparent in all of these measures.

4.2. Ten Year Collision History

Table 1 summarizes the number of collisions occurring annually over the past 10 years. The collisions are broken down by severity into property damage only (PDO), injury, and fatal accidents.

As indicated in Table 1, the number of collisions has decreased over the last ten years, with a reduction of 41% for total collisions and similar reductions for PDO and injury accidents. A steady decline occurred from 1994 through 2000. PDO and total collisions have increased slightly between 2000 and 2003, while injury accidents decreased during this time period.

The annual number of fatal collisions varied between 14 and 27 during the ten-year period. Due to the relatively low number of fatal collisions, evaluation of trends over time would not yield statistically significant results. However, fatalities as a percentage of total collisions have been relatively consistent, ranging between approximately ½ to 1%.

TABLE 2
TEN-YEAR COLLISION HISTORY

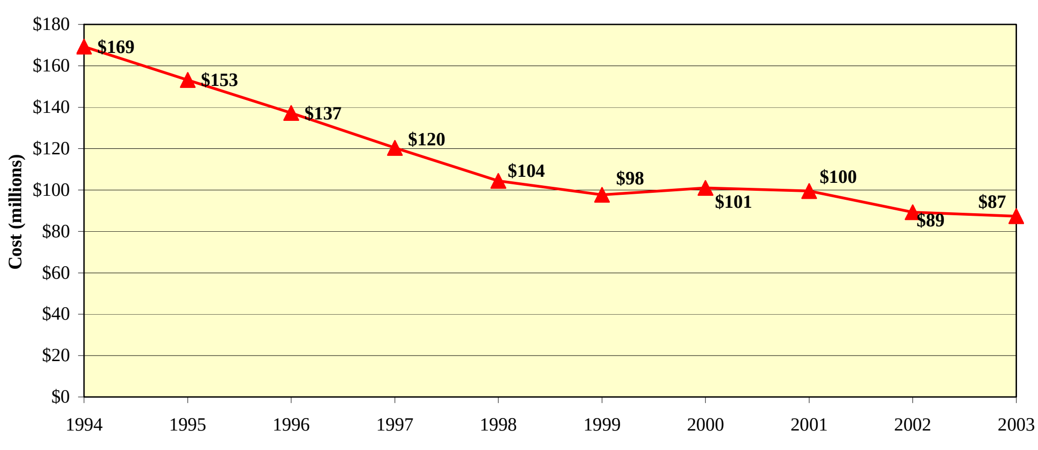
Year	PDO	Injury	Fatal	Total
1994	2545	1954	27	4526
1995	2277	1839	20	4136
1996	2119	1608	20	3747
1997	1697	1310	25	3032
1998	1665	1191	17	2873
1999	1513	1101	17	2631
2000	1365	1043	25	2433
2001	1403	986	27	2416
2002	1571	982	16	2569
2003	1707	971	14	2692
Total	17862	12985	208	31055

Note: Data is not normalized to account for external factors. Normalized data is considered more appropriate when comparing collisions over time.

4.3. Ten Year Societal Cost

Figure 1 shows the estimated annual cost of collisions over the past 10 years. As indicated, the estimated cost of collisions during 2003 was $87 million[3].

Figure 1
Estimated Annual Collision Costs



Note: Data is not normalized to account for external factors. Normalized data is considered more appropriate when comparing collisions over time.

[3] The following estimated costs per accident are used in this calculation: Property Damage Only-$6,000, Injury-$65,000, Fatality-$1,000,000

The cost attributed to collisions has decreased steadily, with a 48% reduction over the ten-year period. It is worth noting that while the number of collisions increased between 2000 and 2003, the cost of these collisions decreased. This is due to a decrease in the severity of the collisions, while PDO accidents increased, the number of injury accidents and fatalities decreased.

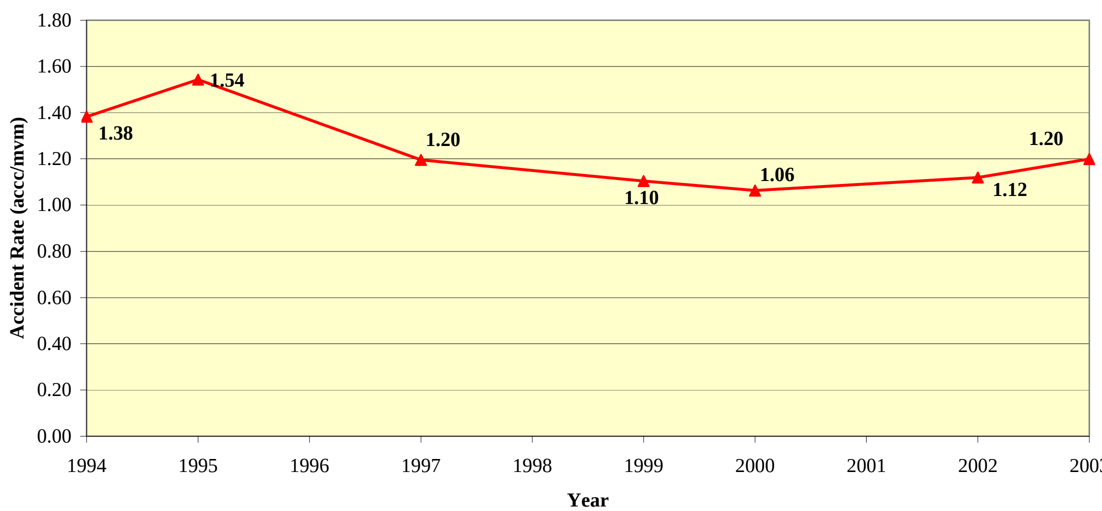
4.4. Ten Year Estimated Accident Rate

The accident rate is frequently used to account for differences in traffic volumes when comparing the number of accidents at different locations or during different time periods. The accident rate is commonly expressed in accidents per million vehicle miles (acc/mvm).

The accident rate is obtained by dividing the number of accidents during a given time period by the number of miles driven during the same time period. Miles driven is determined by multiplying the length of the road by the number of vehicles traveling on the road. This is a fairly straightforward process for an individual roadway. For more complex street networks, the number of miles driven is estimated since traffic volumes are not available for all roads. Further information on determining accident rates is provided in Appendix B.

The estimated accident rate over the past 10 years is shown in Figure 2. The information used in this estimate is provided in Table C3 (Appendix C).

Figure 2
Estimated Accident Rate



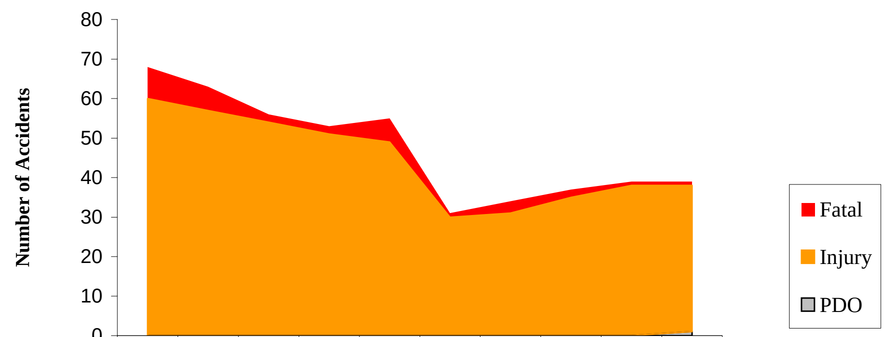
Review of Figure 2 indicates that the estimated accident rate has varied between 1.10 and 1.54 acc/mvm during the last 10 years. No definitive trend is evident.

It should be noted that due to limited data, a number of assumptions were made in estimating the accident rate. While the estimated accident rate is useful to compare changes over time within unincorporated King County, it is not valid as a basis for comparison with accident rates for individual roadways or from other jurisdictions.

4.5. Ten Year Pedestrian and Bicycle Collision History

Figures 3 and 4 show the number of pedestrian and bicycle collisions occurring annually over the past 10 years. The collisions are broken down by severity into property damage only (PDO), injury, and fatal accidents.

Figure 3
Pedestrian Collision History

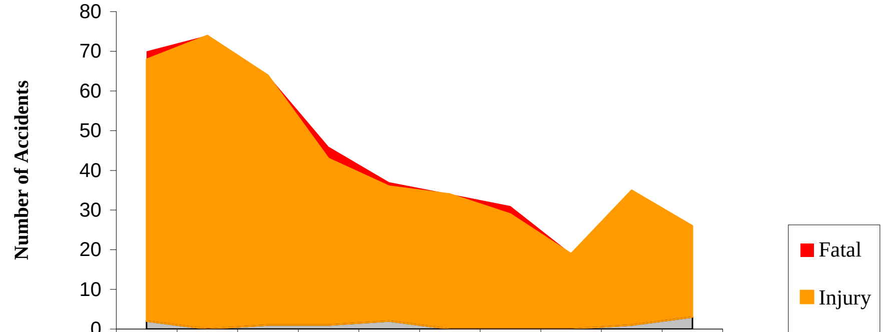


	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Fatal	8	6	2	2	6	1	3	2	1	1
Injury	60	57	54	51	49	30	31	35	38	37
PDO	0	0	0	0	0	0	0	0	0	1

Year

Note: Data is not normalized to account for external factors. Normalized data is considered more appropriate when comparing collisions over time.

Figure 4
Bicycle Collision History



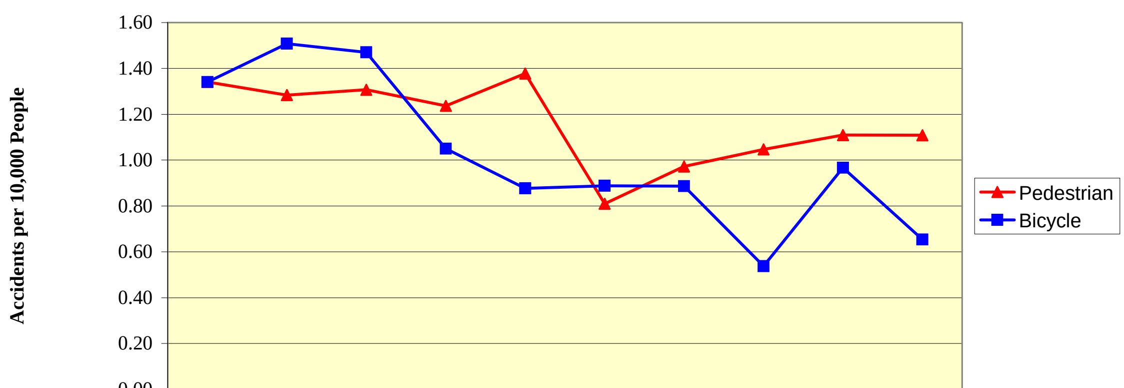
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Fatal	2	0	0	3	1	0	2	0	0	0
Injury	66	74	63	42	34	34	29	19	34	23
PDO	2	0	1	1	2	0	0	0	1	3

Note: Data is not normalized to account for external factors. Normalized data is considered more appropriate when comparing collisions over time.

As indicated in these figures, pedestrian and bicycle collisions have decreased by 43% and 66%, respectively.

Figure 5 shows pedestrian and bicycle collisions per 10,000 residents of unincorporated King County. The pedestrian and bicycle collision rates have decreased by 17% and 51%, respectively.

Figure 5
Pedestrian and Bicycle Collisons per 10,000 Population

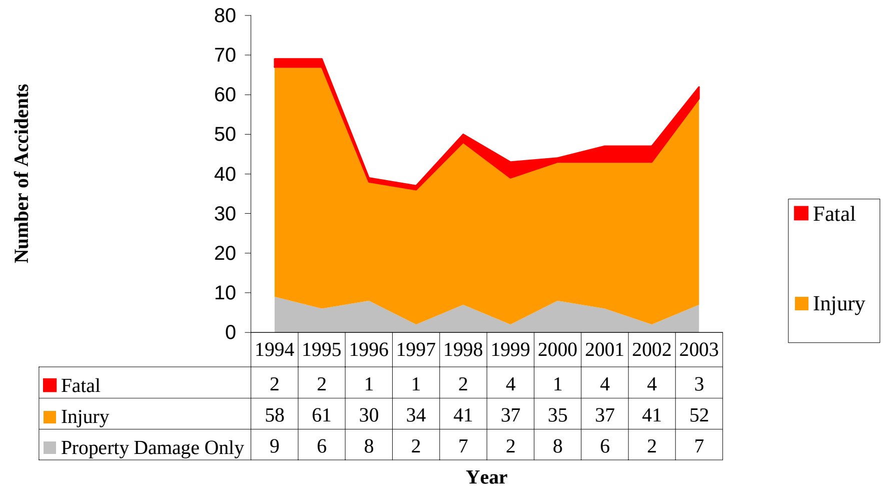


	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Pedestrian	1.34	1.28	1.31	1.24	1.38	0.81	0.97	1.05	1.11	1.11
Bicycle	1.34	1.51	1.47	1.05	0.88	0.89	0.89	0.54	0.97	0.65

4.6. Ten Year Motorcycle Collision History

The ten-year motorcycle collision history is illustrated in Figure 6. The number of motorcycle collisions decreased by nearly 50% in 1996, fluctuated between 1996 and 1999, and then increased every year since that time. Motorcycle collisions have decreased by 10% over the past ten years, but have increased by 44% since 1999.

Figure 6
Motorcycle Collision History



	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Fatal	2	2	1	1	2	4	1	4	4	3
Injury	58	61	30	34	41	37	35	37	41	52
Property Damage Only	9	6	8	2	7	2	8	6	2	7

Note: Data is not normalized to account for external factors. Normalized data is considered more appropriate when comparing collisions over time.

Motorcycle collisions tend to be more severe than accidents involving larger vehicles. Nearly 90% of the motorcycle collisions resulted in injuries or fatalities.

While the number of miles driven by motorcycles is not available, information on the number of registered motorcycles is available from the Washington State Department of Licensing[4]. Approximately 5% of licensed drivers in King County also have motorcycle licenses, and approximately 1% of the registered motor vehicles in King County are motorcycles. Both the number of registered motor vehicles and motorcycles in King County has increased by approximately 25% over the past ten years.

It should be noted that due to the relatively low number of motorcycle collisions, the recent increase would not generally be considered a statistically valid trend. However, considering this increase and the severity of motorcycle collisions, further endeavors in this area may be warranted.

Motorcycle collisions are discussed further in section 5.10.

[4] Department of Licensing figures include both incorporated cities and unincorporated King County

5.0 COLLISION TYPES

A breakdown of collision data according to the more frequent accident types is provided in this section. Factors influencing the frequency of collisions and methods used to reduce the number of collisions are also discussed.

While the discussion in this section focuses on the influence of roadway design, it is important to realize that human and vehicular factors have a great deal of influence on the frequency and severity of collisions. Such factors include driver ability and attention, sobriety, vehicle speed, and vehicle condition. While characteristics such as roadway geometry or congestion may be contributing factors, collisions usually involve either an error in driver judgment or an equipment failure.

Figure 7 shows a breakdown of 2003 collisions by the type of accident. Approximately two-thirds of the accidents fall into one of three categories: run-off-road, rear end, and right angle collisions. Pedestrian and bicycle accidents comprise 1.4% and 1.0% of the accidents, respectively. While these two collision types are less frequent, they receive special attention due to their severity.

Figure 7
2003 Collisions by Accident Type

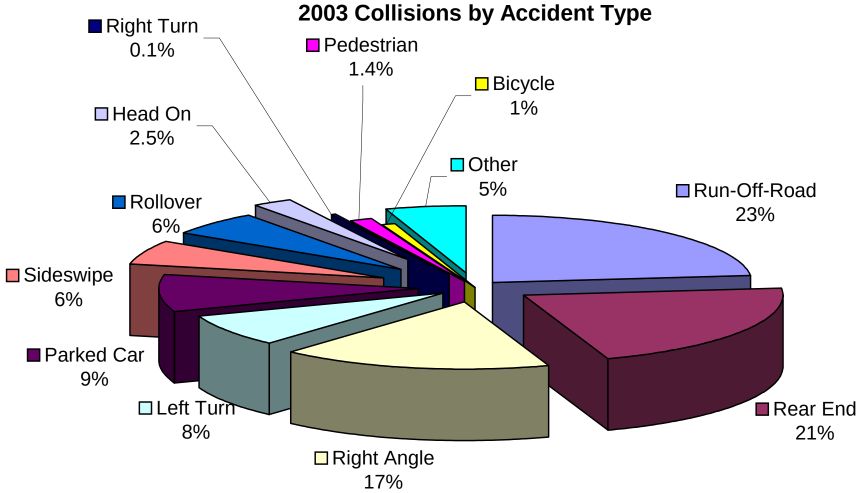
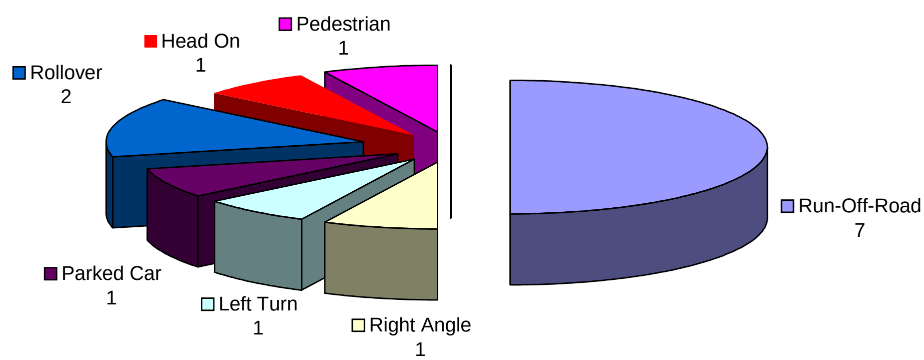


Figure 8 is a breakdown of fatal collisions by accident type. It should be noted that while run-off-road collisions made up approximately one-fourth of the total accidents, they accounted for one-half of the fatal accidents. While this would not be considered statistically significant over a one-year time frame due to the relatively small number of fatal accidents (14 in 2003), review of collision data for the last ten years indicates a nearly identical pattern. Nationwide, approximately one-third of fatal collisions are run-off-road accidents.[5]

Figure 8
2003 Fatal Collisions by Accident Type



A breakdown of collisions by severity and accident type for 2002 and 2003 is provided in Table C1 (Appendix C). This table also includes the estimated societal cost according to type of collision. The following subsections discuss some of the more frequent collision types.

5.1.

[5] NCHRP Report 500, Volume 6: "A Guide for Addressing Run-Off-Road Collisions"

Run-Off-Road Collisions

5.1.1. Definition

A run-off-road collision is defined as an event where a vehicle leaves the traveled portion of the roadway, and is unable to recover prior to encountering an object, body of water, or embankment (ditch). A large number of run-off-road collisions go unreported when the vehicle is able to return to the roadway and drive away after the collision. These tend to be minor collisions but can exceed the $500 reporting threshold, particularly when roadside objects such as guardrail, fire hydrants, and poles are damaged.

Features such as horizontal and vertical curves, narrow roadways, varying shoulder widths, roadside obstacles, and steep embankments tend to increase the frequency of run-off-road collisions. Roadway reconstruction, shoulder widening, and removal of obstacles can reduce the number and severity of run-off-road collisions. Installation of guardrail and other traffic barriers can reduce the severity of these collisions. However, installing barriers may result in a slight increase in the number of collisions since barriers are usually closer to the roadway than the hazards they are shielding.

5.1.2. 2003 Collision Experience

As previously noted, approximately one-fourth of the vehicular collisions in unincorporated King County were run-off-road collisions, making this the most frequent accident type. Seven of the fourteen fatal accidents that occurred in 2003 were run-off-road collisions.

A total of 629 run-off-road collisions occurred during 2003, with an estimated cost of $22.1 million. A breakdown of these collisions according to severity is shown in Figure 9. Two-thirds of the collisions were PDO accidents.

Figure 9
2003 Run-Off-Road Collisions by Severity

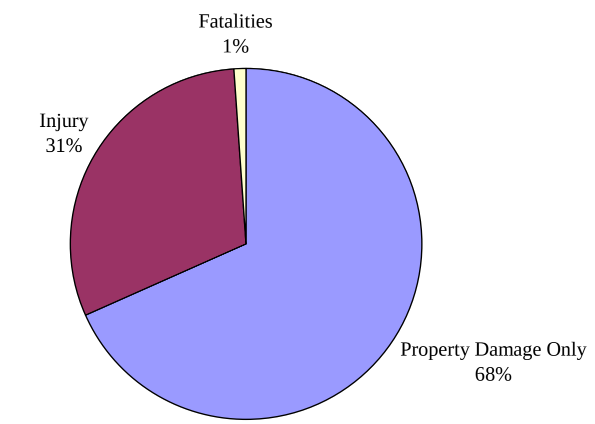
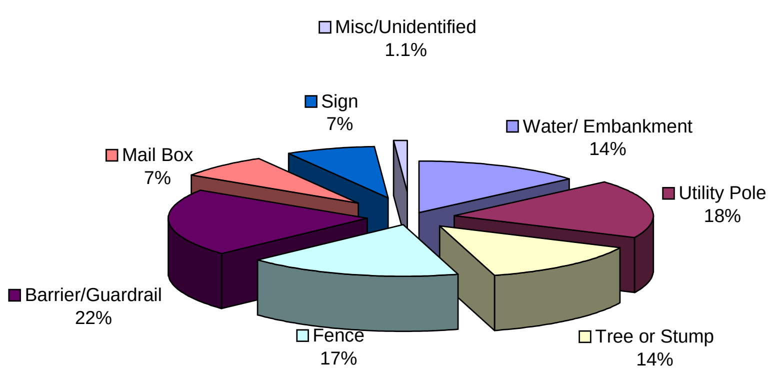


Figure 10 shows a breakdown of run-off-road collisions by the type of object struck. Several objects can be struck during a single collision, and this breakdown refers to the first object encountered according to the Officer's report.

Figure 10
2003 Run-Off Road Collisions by Object Struck



As shown in Figure 10, guardrail and other traffic barriers were the most frequently struck object, comprising nearly one-fourth of the run-off-road collisions. Isolated fixed objects (utility poles, fences, trees, signs and mailboxes) were involved in nearly two-thirds of the run-off-road collisions. Utility poles were the mostly frequently struck isolated fixed objects.

A breakdown of run-off-road collisions by severity and object struck for 2002 and 2003 is provided in Table C2 (Appendix C).

5.2.

Rear-End Collisions

5.2.1. Definition

A rear-end collision occurs when one vehicle runs into the rear of another vehicle that is traveling in the same direction. This accident type does not include collisions with parked cars. In almost all cases, fault is assigned to the driver of the rear vehicle.

Rear-end collisions frequently occur when a vehicle suddenly overtakes another vehicle that has slowed or stopped unexpectedly. The front vehicle may slow or stop at traffic lights or stop signs, prior to turning, when overtaking queues caused by traffic congestion, or in response to emergency situations. Traffic congestion and limited sight distance can increase the number of rear-end collisions.

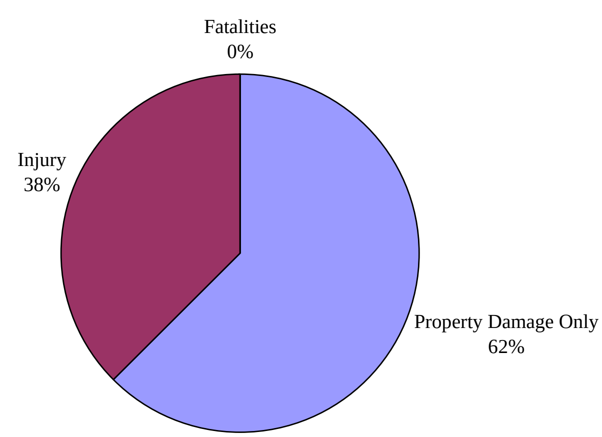
The number of rear-end collisions can frequently be reduced by adding turn lanes, reducing congestion, or improving sight distance. Sight distance improvements include trimming trees, removing visual obstructions, and reconstruction of roadways to reduce horizontal and vertical curvature.

5.2.2. 2003 Collision Experience

As previously noted, nearly one-fourth of the vehicular accidents in unincorporated King County were rear end collisions, making this the second most frequent accident type. A total of 577 rear end collisions occurred during 2003, with an estimated cost of $16.3 million.

A breakdown of these collisions according to severity is shown in Figure 11.

Figure 11
2003 Rear End Collisions by Severity



5.3. Right Angle Collisions

5.3.1. Definition

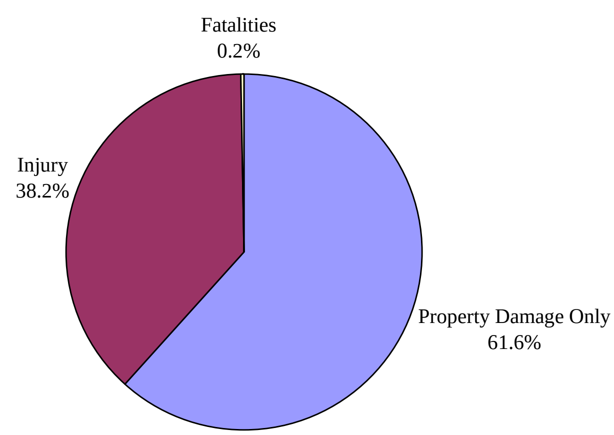
A right angle collision is defined as a collision where one vehicle enters a roadway and is struck by a second vehicle at an angle of approximately 90 degrees. The entering vehicle may be entering from a driveway or another street, and may be attempting to cross the street or turning right. A right angle collision occurs because one of the vehicles fails to yield the right-of-way, whether assigned by a traffic signal, yield or stop sign, or by state law (in the case of driveways and unsigned intersections).

Right angle collisions occur most frequently at locations where driveways or minor streets intersect higher volume streets, particularly where traffic congestion or limited sight distance is present. Engineering solutions include traffic controls such as four-way stop control, signals, and roundabouts, and sight distance improvements. Driveway collisions can usually be reduced by access control measures such as closing or relocating driveways, or prohibiting movements such as left turns. All of these solutions can have undesirable side effects, including increases in other types of accidents. For this reason these improvements need to be carefully evaluated prior to implementation to ensure that the benefits outweigh the limitations.

5.3.2. 2003 Collision Experience

Right angle collisions were the third most frequent type of accident, comprising 17% of accidents during 2003. A total of 456 right angle collisions occurred, with an estimated cost of $14.0 million. A breakdown of these collisions according to severity is shown in Figure 12.

Figure 12
2003 Right Angle Collisions by Severity



5.4. Left Turn Collisions

5.4.1. Definition

A left turn collision occurs when one vehicle attempting to make a left turn collides with another vehicle traveling in the opposite direction. State law requires the left turning vehicle to yield to oncoming traffic unless a sign or traffic signal indicates otherwise.

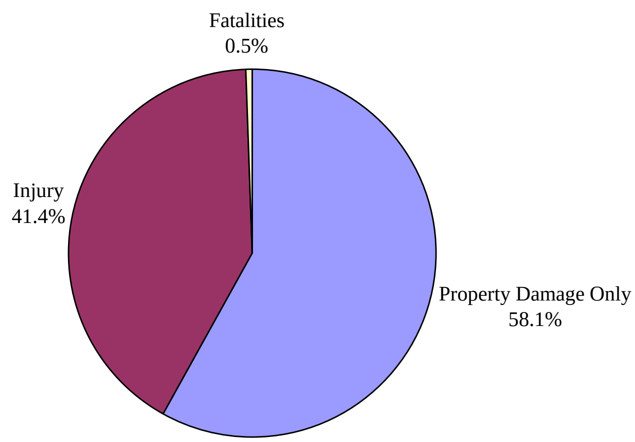
The number of left turn collisions may be higher at locations with high traffic volumes, congestion, or limited sight distance. Improvements such as left turn lanes and left turn signal phasing[6] are frequently used to reduce the number of left turn collisions.

5.4.2. 2003 Collision Experience

Eight percent of the accidents during 2003 were left turn collisions. A total of 210 left turn collisions occurred, with an estimated cost of $7.4 million.

A breakdown of these collisions according to severity is shown in Figure 13.

Figure 13
2003 Left Turn Collisions by Severity



[6] Left turn signal phasing uses a "green arrow" signal head and provides a "protected" movement for left turning vehicles

5.5. Parked Car Collisions

5.5.1. Definition

Parked car collisions occur when a vehicle leaves the road and collides with a vehicle outside of the traveled portion of the roadway. The parked vehicle can be occupied and running, but cannot be moving. This collision type does not include accidents that occur in parking lots or other privately owned areas unless the parked vehicle is located adjacent to a roadway and is struck by a vehicle that departed from the roadway immediately prior to the collision. This collision type also excludes accidents with vehicles stopped in travel lanes (e.g. vehicles stopped at a signal or while waiting to turn).

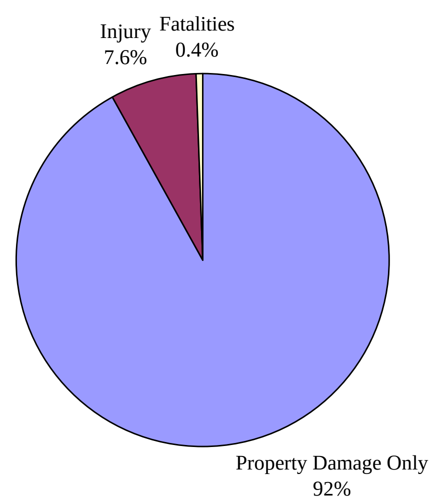
This type of collision occurs most frequently on roadways with on-street parking. Factors that can increase the number of parked car collisions include limited sight distance, high speeds and volumes, retail land use, and wide roadways with no lane designation. Improvements to reduce the number of parked car collisions include parking prohibitions, adding striping to differentiate between travel and parking lanes, and increasing the width of parking areas.

5.5.2. 2003 Collision Experience

Nine percent of the accidents during 2003 were parked car collisions. A total of 236 parked car collisions occurred, with an estimated cost of $3.5 million.

A breakdown of these collisions according to severity is shown in Figure 14. As indicated in this figure, over 90% of parked car collisions in 2003 were property damage only.

Figure 14
2003 Parked Car Collisions by Severity



5.6. <u>Sideswipes</u>

5.6.1. Definition

A sideswipe is defined as a shallow-angle collision. Typically the vehicles are traveling on the same roadway, and can be moving in the same or opposite directions.

Same direction sideswipes frequently occur in areas where lane changes, merging or sudden stops are required. These collisions can frequently be reduced using the same approaches as for rear-end accidents.

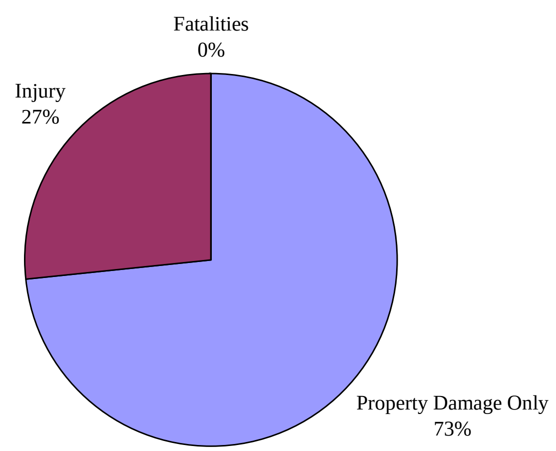
Features such as horizontal and vertical curves, narrow roadways, varying lane widths, and merging zones tend to increase the frequency of opposite direction sideswipes. Typical improvements include roadway reconstruction and centerline treatments such as rumble strips, medians, and islands.

5.6.2. 2003 Collision Experience

Six percent of the accidents during 2003 were sideswipes. A total of 157 sideswipes occurred, with an estimated cost of $3.4 million.

A breakdown of these collisions according to severity is shown in Figure 15. As indicated, nearly three-fourths of sideswipes in 2003 were PDO accidents.

Figure 15
2003 Sideswipe Collisions by Severity



5.7. <u>Head-On Collisions</u>

5.7.1. Definition

A head-on collision occurs when two vehicles traveling in opposite directions collide at little or no angle.

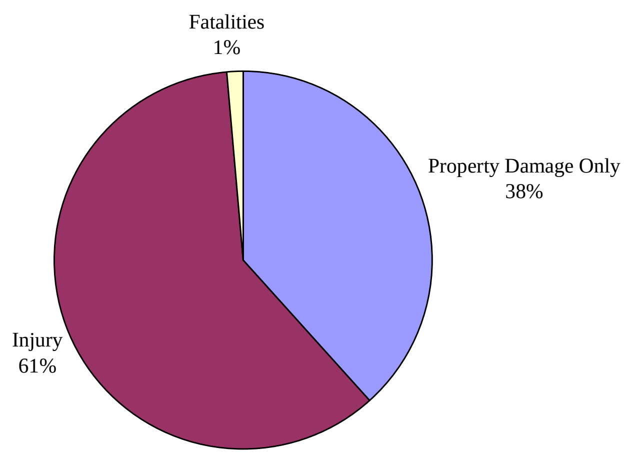
As with opposite direction sideswipes, features such as horizontal and vertical curves, narrow roadways, varying lane widths, and merging zones tend to increase the frequency of head-on collisions. Typical improvements include roadway reconstruction and centerline treatments such as rumble strips, medians, and islands.

5.7.2. 2003 Collision Experience

Three percent of the accidents during 2003 were head-on collisions. A total of 68 collisions occurred, with an estimated cost of $3.8 million.

A breakdown of these collisions according to severity is shown in Figure 16. As indicated by this figure, head-on collisions tend to be more severe than most other accident types.

Figure 16
2003 Head-on Collisions by Severity



5.8.

Pedestrian Collisions

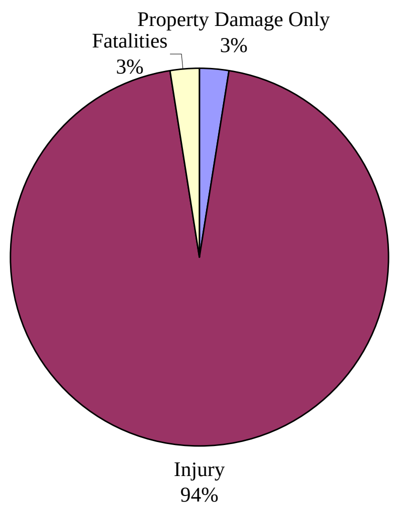
Reported pedestrian collisions are infrequent, but receive special attention due to their severity. Pedestrian collisions that do not result in injuries are rarely reported, and therefore the frequency of these accidents is not known.

A number of approaches are utilized with the intention of reducing the number of pedestrian collisions. These approaches include physical improvements such as pathways, sidewalks, and enhanced crosswalks; and other actions such as providing crossing guards at schools, education, and enforcement of jaywalking and speed limit laws. Due to the infrequent nature of these collisions, it is difficult to assess the impact of improvements at specific locations unless large numbers of pedestrian collisions have occurred.

5.8.1. 2003 Collision Experience

Pedestrian collisions comprised 1.4% of the accidents during 2003. A total of 39 collisions occurred, with an estimated cost of $3.4 million. A breakdown of pedestrian collisions according to severity is shown in Figure 17.

Figure 17
2003 Pedestrian Collisions by Severity



An area of significant concern is the age of pedestrian involved in collisions. Figure 18 provides a breakdown according to the age for 2003 collisions. Due to the relatively low number of pedestrian collisions during a given year, it is useful to look at a longer time period. Figure 19 provides the same breakdown for collisions over the last 10 years.

Figure 18
2003 Pedestrian Collisions by Age

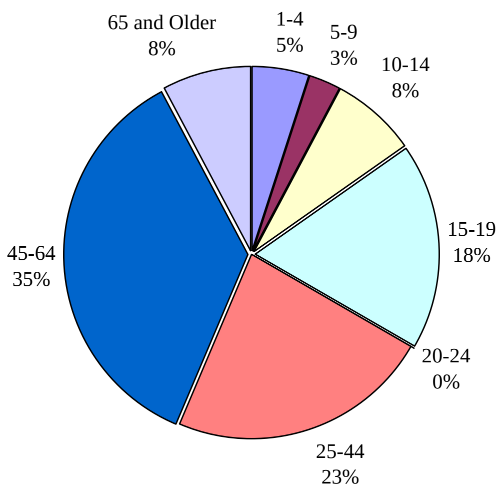
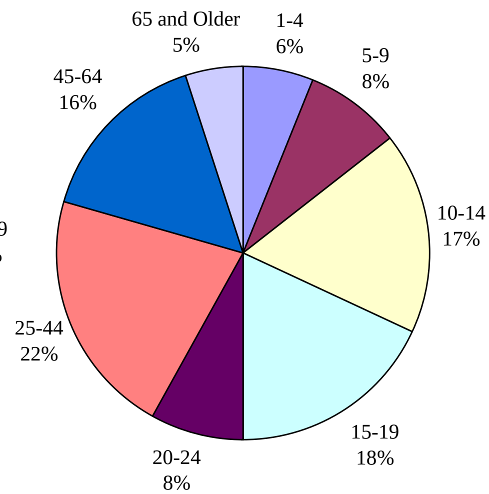


Figure 19
1994-2003 Pedestrian Collisions by Age



As indicated in Figure 19, approximately one-half of the collisions in the past 10 years involved pedestrians under age 20. This may be an appropriate area for additional focus with respect to safety efforts.

The data was also reviewed for pedestrian collisions within school zones. No pedestrian collisions took place in school zones during 2003. Over the past ten years, there have been three collisions within school zones that involved pedestrians.

The pedestrian action and priority of pedestrian collisions over the last 10 years are summarized in Table 3. Priority refers to whether the pedestrian or vehicle had the right of way at the time of collision.

TABLE 3
PEDESTRIAN COLLISIONS BY ACTION AND PRIORITY
(1994-2003 TOTALS)

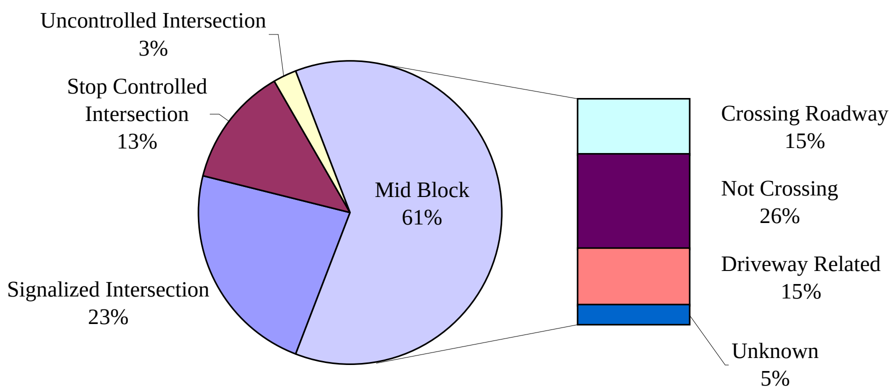
Action	Priority	Total Number	Percentage
Crossing at Intersection	Priority Given to Pedestrian	148	31%
Crossing at Intersection	Priority Given to Vehicles	26	5%
Crossing, Non-Intersection	Priority Given to Pedestrian	0	0%
Crossing, Non-Intersection	Priority Given to Vehicles	114	24%
Walking on Roadway Shoulder	Priority Given to Pedestrian	43	9%
Walking on Roadway No Shoulder	Priority Given to Pedestrian	31	7%
Walking or Standing In Roadway	Priority Given to Vehicles	43	9%
Other		70	15%
Total		**475**	**100%**

As indicated in this table, 60% of pedestrian collisions occurred while the pedestrian was crossing the road. Thirty-six percent of the collisions occurred at intersections, while 24% occurred when a pedestrian was crossing at a non-intersection location. In collisions where the priority was determined, pedestrians had the priority in 55% of the time.

Figure 20 provides a breakdown of 2003 pedestrian collisions by location. Nearly two-thirds of the collisions occurred at mid block (non-intersection) locations. The mid block locations are further broken down into pedestrians crossing the roadway (15%), not crossing the roadway (standing in or near the road, 26%) and driveway related collisions (15%). Review of collision reports indicates that two of the 39 pedestrian collisions occurred after motorists or passengers left their vehicle due to an accident or breakdown.

39% of the collisions occurred at intersections. Of these, 60% were located at signalized intersections, 30% occurred at stop controlled intersections, and the remainder took place at uncontrolled intersections.

Figure 20
2003 Pedestrian Collisions by Location



Note: Uncontrolled intersection refers to an intersection where no controls such as stop signs, yield signs, or traffic signals are present. At such intersections, state law requires motorists to yield to any vehicles on their right.

Tables C4 through C6 (Appendix C) provide additional information on pedestrian collisions.

5.9.

Bicycle Collisions

As with pedestrian collisions, bicycle collisions are infrequent, but receive special attention due to their severity.

5.9.1. Definition

The bicycle collision category includes all collisions with human-powered wheeled vehicles, and for this reason the category is sometimes referred to as "pedalcycle" collisions.

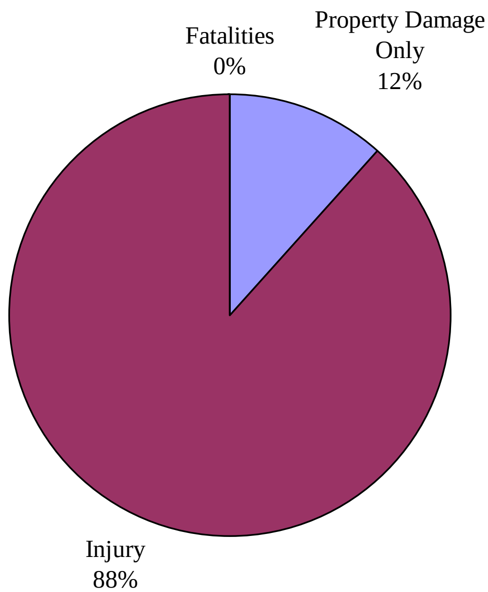
A number of approaches are utilized with the intention of reducing the number of bicycle collisions. These approaches include physical improvements such as wider shoulders, bike lanes, and separated pathways; and other actions such as education and enforcement. Due to the infrequent nature of these collisions, it is difficult to assess the impact of improvements at specific locations.

5.9.2. 2003 Collision Experience

Bicycle collisions comprised 1.0% of the accidents during 2003. A total of 26 collisions occurred, with an estimated cost of $1.5 million.

A breakdown of bicycle collisions according to severity is shown in Figure 21.

Figure 21
2003 Bicycle Collisions by Severity



As with pedestrian collisions, the age of the cyclist is an area of concern. Figures 22 and 23 provide a breakdown according to the age for collisions in 2003 and over the past ten years. Table C7 (Appendix C) provides this information in tabular form.

Figure 22
2003 Bicycle Collisions by Age

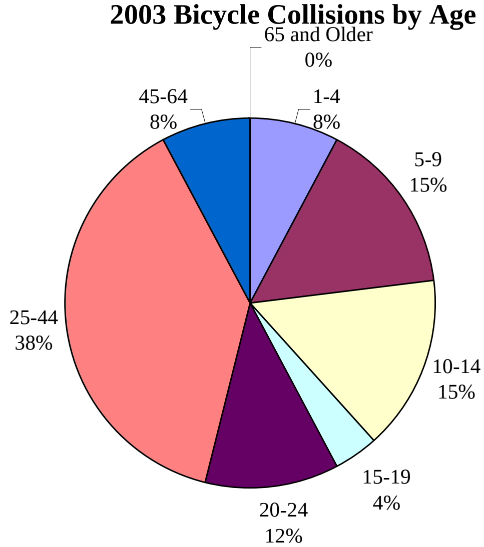
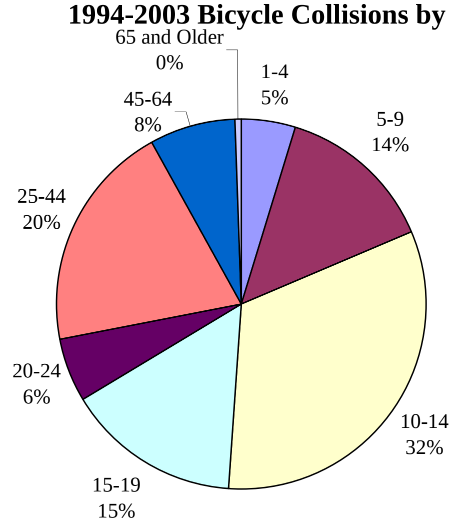


Figure 23
1994-2003 Bicycle Collisions by Age



As indicated in Figure 23, approximately two-thirds of the collisions in the past 10 years involved cyclists under age 20. As with pedestrian collisions, younger cyclist collisions may warrant additional safety efforts.

Table 4 provides a summary of bicycle collisions over the past ten years according to collision type. The collision type was not identified in nearly half of these collisions. Approximately one-half of the remaining collisions involved cyclists crossing or entering traffic.

TABLE 4
BICYCLE COLLISIONS BY COLLISION TYPE
(1994-2003)

Collision Type	Total Number	Percentage
Crossing or Entering Traffic	112	26%
Riding With Traffic	46	11%
Riding Against Traffic	33	8%
Turned into Vehicle Path	31	7%
Fell or pushed into vehicle	3	1%
Unidentified	211	48%
Total	**436**	**100%**

5.10.

Motorcycle Collisions

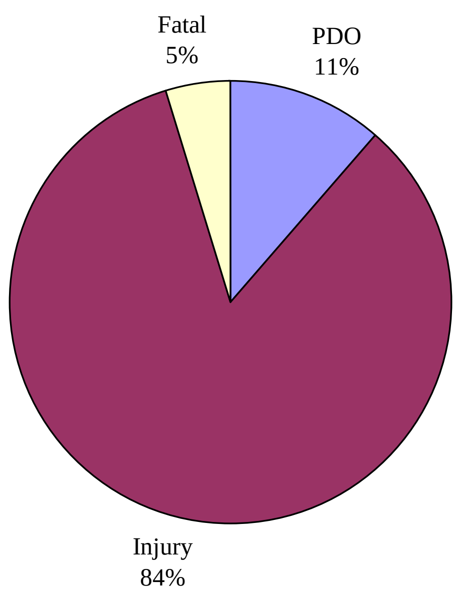
Motorcycle collisions tend to be severe due to the limited protection provided by motorcycles when compared with passenger cars and other enclosed vehicles. Passage and enforcement of helmet laws are probably the most effective means of reducing the severity of motorcycle collisions. Education may be effective in reducing the frequency of these collisions.

5.10.1. 2003 Collision Experience

Motorcycle collisions comprised 2.3% of the accidents during 2003. A total of 62 collisions occurred, with an estimated cost of $6.4 million. Three fatal accidents occurred, more than any other category except run-off-road collisions.

A breakdown of motorcycle collisions according to severity is shown in Figure 24. As indicated, nearly 90% of the collisions were injury or fatal accidents. As noted in section 4.6, due to the severity of motorcycle collisions and recent increases in the number of collisions, further effort in this area (e.g. education and licensing requirements) may be warranted.

Figure 24
2003 Motorcycle Collisions by Severity



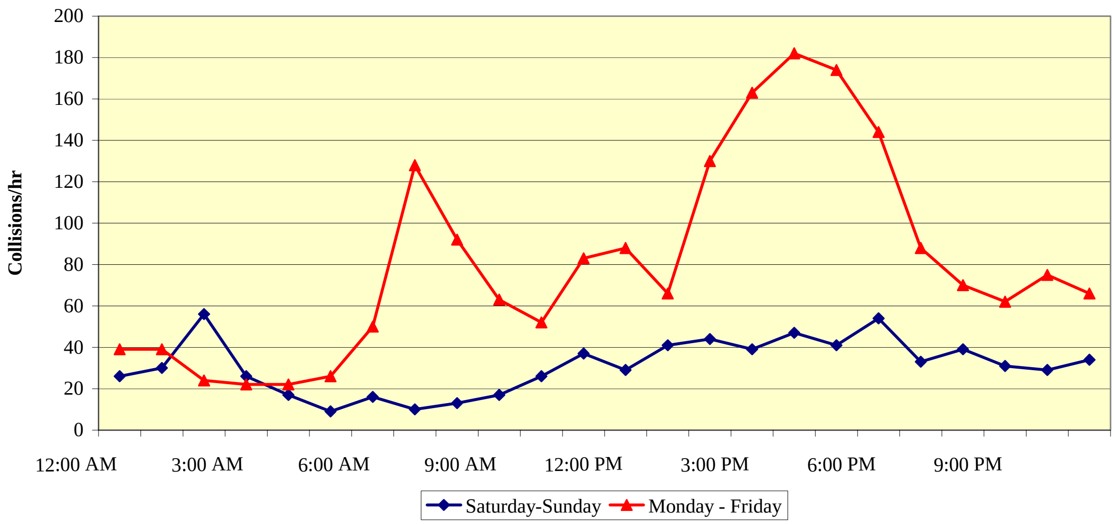
6.0 OTHER COLLISION INFORMATION

This section provides information on collisions by miscellaneous categories such as the time of day, road surface conditions, and circumstances contributing to the accident. As with the previous section, strategies for reducing the number of collisions are also discussed. A special studies subsection focusing on particular areas of interest is also included. The areas of focus for this subsection will vary from year to year.

6.1. Time and Day of Week

Figure 25 illustrates the relationship between collisions and the time of day, with a breakdown by weekdays and weekends. As expected, the majority of collisions occurred during the weekday AM and PM peak periods. In general, there appears to be a strong correlation between traffic volumes and collision frequency. A notable exception is during weekends between 2 and 4 AM, when the number of collisions appears to be higher in proportion to the number of vehicles on the road.

FIGURE 25
2003 COLLISIONS BY TIME OF DAY AND WEEK

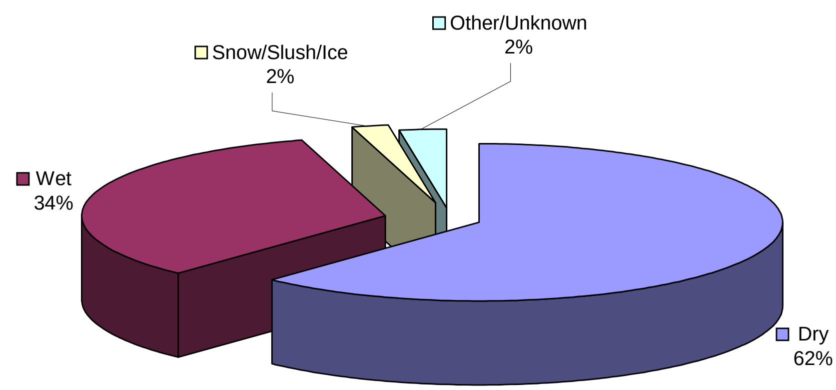


6.2.

Weather and Road Surface Conditions

Inclement weather can decrease visibility and create situations that distract drivers. In addition, wet, snowy, or icy pavement greatly increases stopping distance and decreases maneuverability. Figure 26 provides a breakdown of collisions according to road surface conditions. Nearly two-thirds of the collisions occurred when the roadway was dry. Comparison according to severity indicates that in 2003, the percentages of property damage only, injury, and fatal collisions were nearly identical for wet and dry road surface conditions.

Figure 26
2003 Collisions by Road Surface Condition



6.3.

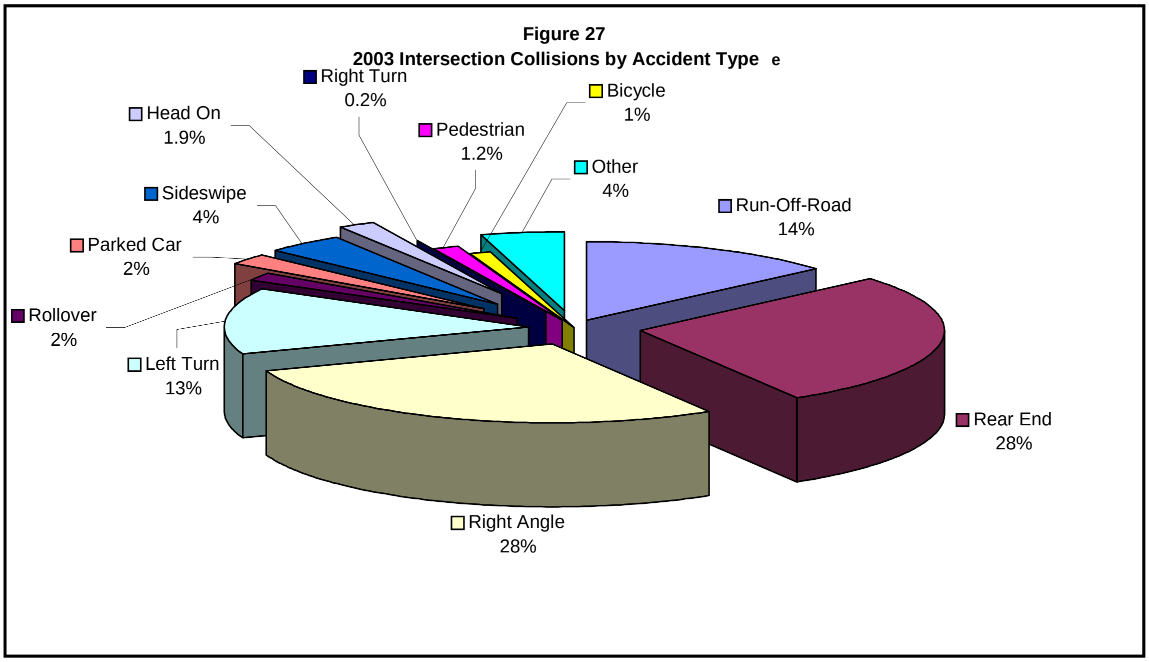
Collision Locations

6.3.1. Intersection and Non-intersection Collisions

Intersections constitute only a small portion of the roadway system, yet national statistics indicate that more than 50% of collisions in urban areas and over 30% of collisions in rural areas occur at intersections. This is expected, since intersections are the point on the roadway system where traffic movements most frequently conflict with one another.[7]

Within unincorporated King County, 44% percent of the collisions in 2003 occurred at intersections. King County roadways vary from rural to urban in character. As expected, the percentage lies between the national averages for rural and urban areas.

Figure 27 provides a breakdown of intersection collisions by accident type. As indicated, the highest collision types at intersections were rear-end (28%), right angle (28%), run-off-road (14%), and left turn (13%) collisions. These four accident types comprise over 80% of the collisions at intersections.



[7] NCHRP Report 500, Volume 5 "A Guide for Addressing Unsignalized Intersection Collisions"

Figure 28 provides a breakdown of non-intersection collisions by accident type. Nearly one-third of the non-intersection collisions were run-off-road accidents, making this the most frequent accident type. Rear-end (16%) and parked car (14%) collisions were the second and third most common collision types.

Figure 28
2003 Non-Intersection Collisions by Accident Type

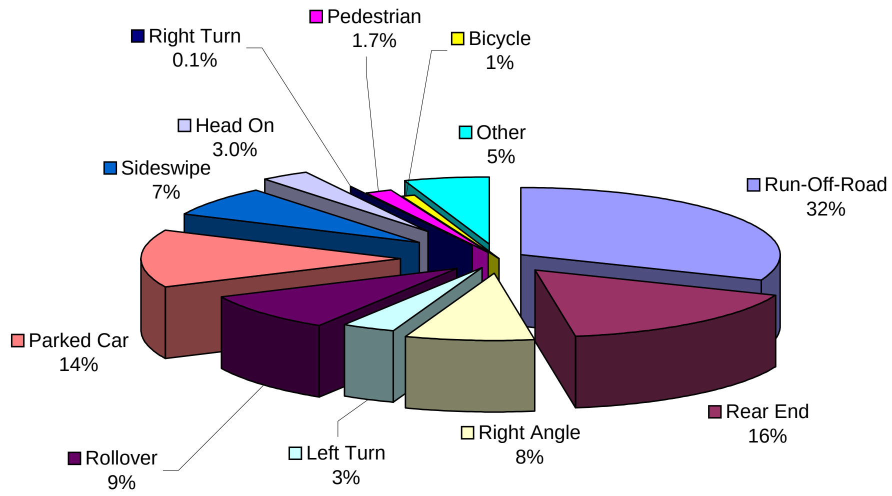


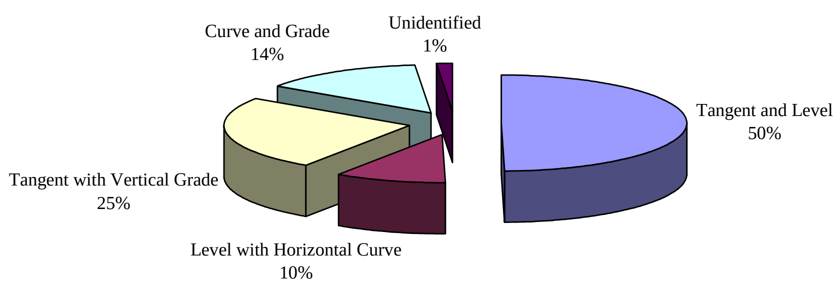
Table C8 (Appendix C) provides additional information on collisions according to location.

6.3.2. Roadway Alignment

Horizontal curves, steep grades, and vertical curves present additional challenges to drivers, and result in an increased risk of collisions. National statistics indicate that the accident rate on horizontal curves is nearly three times higher than on tangent[8] sections. It should be noted that fewer collisions occur on curves than on tangent sections, but the accident rate is higher on curves since they comprise a small percentage of the total road miles.[9]

Figure 29 provides a breakdown of collisions according to roadway alignment. As indicated, 50% of the collisions occurred on level, tangent sections, 49% occurred on horizontal curves or grades, and 1% had no identified roadway alignment.

Figure 29
2003 Collisions by Roadway Alignment



The accident rate would be the most meaningful way to compare collisions according to road alignment, since it accounts for roadway length. However, accident rates cannot be determined at the present time since mileage according to roadway alignment is not available for King County.

[8] Tangent refers to a roadway with little or no horizontal curves.
[9] NCHRP Report 500, Volume 7: "A Guide for Reducing Collisions on Horizontal Curves".

Table C8 in Appendix C provides a breakdown of collisions according to roadway alignment and collision type. Left turn, parked car, pedestrian and bicycle collisions were split fairly evenly according to alignment, with 40% to 60% of collisions occurring on tangent and level sections. Most right turn and right angle collisions took place on tangent and level sections, while the majority of the run-off-road, sideswipe, and head-on collisions occurred on horizontal curves or grades.

6.3.3. Arterials with Highest Accident Rates

Table 5 lists the ten arterial roadways with the highest accident rates. The accident rates for these roadways range from 15.67 to 10.04 acc/mvm.

TABLE 5
ARTERIAL ROADWAYS WITH HIGHEST ACCIDENT RATES
(HIGHEST 10)

Rank	Roadway	From	To	Classification	Length (miles)	Accident Rate (acc/mvm)
1	S 120th St	Des Moines Mem Dr S	Military Rd S	Collector	0.39	15.67
2	SE 128th St	15400 Block	156th Ave SE	Principle	0.31	12.63
3	S 118th St	Glendale Way S	Des Moins Mem Way S	Collector	0.16	12.29
4	S 321 St	Peasly Canyon Rd S	51st Ave S	Collector	0.46	12.16
5	Military Rd S	Des Moines Mem Dr S	S 128th St	Minor	1.06	10.82
6	34th Ave S	S 288th St	S 298th St	Collector	0.58	10.76
7	78th Ave S, S 112th St, 80th Ave S, Lkrdg Dr	Rainier Ave S	S Langston	Collector	1.67	10.75
8	148th Ave SE	SE May Valley Rd	SE 128th	Collector	1.94	10.20
9	17th Ave SW, 16th Ave SW, W/C Cutoff	Roxbury	116th	Principle	1.34	10.14
10	NE 80th St	W Snoq Valley Rd NE	Ames Lake Carn Rd NE	Minor	0.81	10.04

Source: 2003 Accident Rates for Arterial Roadways, Traffic Data Analysis Group. Accident rates based on 2001-2003 accident data.

Improvement projects are planned or have been recently constructed on many of these roadways. These are reviewed in Section 7 of this report.

6.3.4. Geographic Distribution

Collision data is coded geographically using Traffic Engineering's route order system. Preliminary attempts have been made to translate the route order into a coordinate-based system so that accidents and other Traffic information can be included in King County's Geographical Information System (GIS) database. While completing this task will require significant resources, the ability to review collision locations with GIS would provide significant benefits. Completing the conversion is included as a recommendation in Section 8 of this report.

6.4.

Demographics

A breakdown of collisions by driver age and gender is provided in Table 6.

TABLE 6 2003 COLLISIONS BY AGE AND GENDER				
Age	**Male**	**Female**	**Total**	**Percentage**
16-24	761	549	1310	35%
25-34	416	268	684	18%
35-44	416	274	690	18%
45-54	328	243	571	15%
55-64	164	112	276	7%
65-74	64	49	113	3%
75 and Older	51	35	86	2%
Total	**2200**	**1530**	**3730**	100%
Note: Total exceeds number of collisions since some collisions involve multiple drivers.				

Over one-third of the drivers involved in collisions were between 16 and 24 years old. Education and outreach for younger drivers may be an appropriate area for additional focus, and is included as a recommendation in Section 8.

Drivers age 65 and over were involved in 5% of the collisions. Older drivers are involved in fewer collisions, but they tend to drive less frequently and for shorter distances. Nationwide, the accident rate for older drivers is higher than for the driving population as a whole. Accidents involving elderly drivers also tend to be more severe. The number of older drivers in the United States is expected to double over the next 30 years, and this area is the subject of considerable discussion among roadway safety professionals. [10]

6.5.

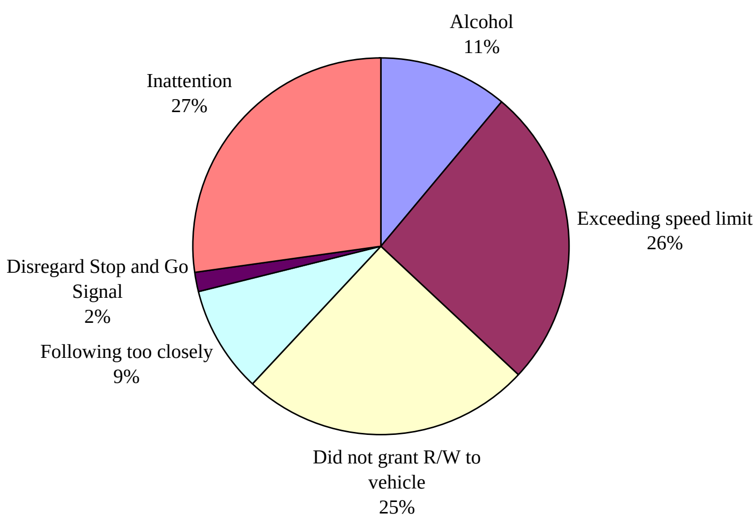
[10] NCHRP Report 500, Volume 9, "A Guide for Reducing Collisions Involving Older Drivers"

Contributing Circumstances

A collision is the result of a series of events referred to as contributing circumstances. The nature of the collision would be changed if any of these circumstances had not occurred, and in many cases the collision would not have taken place at all.

Figure 30 provides a breakdown of collisions by contributing circumstance. There are several contributing circumstances involved in every collision, and the circumstance provided is the one listed on the Officer's report.

Figure 30
2003 Collisions by Contributing Circumstances



6.6.

Special Studies

The special studies subsection provides an opportunity to focus on particular areas of interest each year. The relationship between pavement condition and bicycle and motorcycle accidents is addressed in this report.

6.6.1. Bicycle and Motorcycle Wet Pavement Collisions

Wet pavement increases the stopping distance for bicycles and motor vehicles. Rainy conditions also decrease maneuverability and visibility. These factors would be expected to increase the number of motorcycle and bicycle collisions during rainy weather. However, many motorcyclists and bicyclists avoid riding during rainy weather, which would decrease the number of collisions. Review of accident data from 1994 through 2003 indicates that approximately 15% of the bicycle and 8% of motorcycle collisions occurred under wet pavement conditions. This suggests that the number of collisions during inclement weather is influenced more by the decrease in motorcycle and bicycle use during inclement weather than by the increased risk to these road users.

6.6.2. Defective Equipment

Defective equipment can range from severe deficiencies such as non-working brakes to less serious items such as a broken turn signal. Defective equipment was found in vehicles in 123 of the collisions that occurred during 2003. It is likely that there are many additional collisions where defective equipment was present but not discovered.

7.0 SAFETY RELATED PROJECTS AND PROGRAMS

Safety is our highest priority, and is a fundamental component of all Road Services Division Projects and Programs. This section highlights some of the projects and programs utilized by KCDOT in the ongoing effort to reduce the frequency and severity of collisions.

The Traffic Engineering Section manages many of these programs. An organizational chart for Traffic Engineering is included in Appendix C.

7.1. Roadside Safety

Run-off-road collisions were the most common accident type in 2003, and accounted for seven of the fourteen fatal accidents. The Countywide Guardrail Program focuses on locations with a high risk of these collisions. The goal of this program is to reduce the frequency and severity of run-off-road collisions by improving the roadside environment.

While barrier systems such as guardrail can shield vehicles from roadside hazards, they also present an obstacle that can be struck by vehicles. For this reason, barriers should only be installed where other measures (such as removing the hazard) are not feasible, and where the risk presented by the barrier is less than the hazard it is shielding. KCDOT assesses potential guardrail locations using a series of criteria established by the Washington State Department of Transportation (WSDOT). These criteria are referred to as guardrail warrants.[11]

7.1.1. New Installations

During the 1980s, KCDOT completed an inventory of roadways meeting guardrail warrants. As a result of this "roadside inventory," a guardrail priority array was established in 1988, and updated in 1995 and 2003[12]. There are currently 107 guardrail corridors on the priority array. Each year barriers are constructed on the corridors at the top of the list via the Countywide Guardrail Project.

Prior to installing a barrier system, each location is evaluated to see if meets WSDOT guardrail warrants. If feasible, the risk is mitigated by removing the hazard rather than installing a barrier. In addition to installing barriers, the Countywide Guardrail Program removes hazardous objects and widens shoulders to improve roadside safety.

The 2003 Countywide Guardrail Project installed 12,450 linear feet of guardrail at a total construction cost of $322,500. A portion of the design and construction costs were reimbursed through a federal Hazard Elimination System (HES) grant.

[11] WSDOT Design Manual, Chapter 700 and 710.
[12] King County Roadside Barrier Program, Priority Array Development, Phase 2. September, 2003.

7.1.2. Existing Barriers

King County currently has 1,822 barrier systems with a total length of over 550,000 linear feet. Over the past 20 years there have been significant advances in the design of barrier systems. As a result, older barrier systems are being recognized as a risk to motorists when compared with modern systems.

An inventory of all barrier systems within Unincorporated King County was completed during 2001. This inventory was used as the basis for the Retrofit Priority Array. The Retrofit Priority Array was completed in 2003, and ranks existing barriers that are in need of upgrading[13]. Upgrading of the barrier systems on this array is scheduled to begin in 2005.

Damage to existing barriers occurs primarily due to collisions and fallen trees. Damaged guardrails are repaired by the Roads Maintenance Special Operations crew, with design support from the Traffic Engineering Section. Damaged barriers that no longer meet current standards are either upgraded or replaced "in kind".

In addition to repair and upgrade of damaged systems, the Special Operations crew is also occasionally called on to remove barrier systems that no longer meet guardrail warrants. Many of these systems were installed prior to established warrants, or are at a location where the hazard has been removed.

7.2. HAL/HARS

King County maintains lists of High Accident Locations (HALs) and High Accident Road Segments (HARSs). The accident history, configuration, and operational characteristics are reviewed for each location on the HAL and HARS lists. This information is used to select, prioritize, and implement safety improvements.

Creation of a continually funded HAL/HARSs Program was proposed during 2002, and annual funding for the program began in 2003. The program is responsible for periodically updating the HAL/HARS list, managing and tracking safety improvement projects, and completing Before/After studies for completed safety improvement projects. The primary goal of the program is to address safety in the most cost-efficient manner by directing limited resources at the most effective improvements.

[13] King County Roadside Barrier Program, Priority Array Development, Phase 2. September, 2003.

7.2.1. 1996 HAL/HARS

During 2003, work continued on the 1996 HAL/HARS, which were based on accident data for the three-year period from 1992 through 1994. This list contains 100 HALs and 50 HARS. The status of these projects as of December 2003 is summarized in Table 7.

TABLE 7
STATUS OF 1996 HAL/HARSs

	Number of HALs	Number of HARSs	Total
Completed with Afterstudy	25	10	35
Completed	28	16	44
Construction	2	0	2
Design	5	3	8
Planned	7	6	13
Hold	1	0	1
Unfunded	4	0	4
No Recommendation	6	6	12
Annexed*	22	9	31
Total	100	50	150

Source: 1996 HAL/HARS Status Worksheet
** No longer in Unicorporated King County due to incorporation or annexation. Safety improvements were completed at some locations prior to incorporation/annexation.*

As indicated in this table, the majority of the 1996 HALs and HARSs have been completed, have no recommended improvement, or are now within incorporated areas. Twenty-three projects are in the planning, design or construction phase, and one is on hold pending design and construction by the City of Bellevue. The remaining four projects were unfunded as of December 2003.

7.2.2. 2002 HAL/HARS

A new HAL/HARS list was compiled based on 1998 to 2000 accident data, and a report with proposed improvements and priority ranking was completed in July 2003. The list contains 48 HALs and 51 HARSs. The estimated cost to complete all of the proposed improvements is $34,700,000. Thirty-one HALs and twenty-eight HARSs have been selected as cost-effective improvement projects based on benefit/cost analysis, with a total estimated cost of approximately $10,000,000.

A breakdown by project type and cost is provided in Table 8. Design and construction of 22 new projects began in 2004.

TABLE 8 2002 HAL/HARSs: PROJECT BREAKDOWN			
	Number of HALs	Number of HARSs	Combined
Breakdown By Project Type			
Previously Completed	11	13	24
Sign	3	3	6
Channelization	3	16	19
Signal	16	3	19
CIP	15	16	31
Total	**48**	**51**	**99**
Breakdown By Project Cost			
Previously Completed (N/A)	11	13	24
< $20k	7	18	25
$20-$100k	8	3	11
$100k-$1M	19	10	29
> $1M	3	7	10
Total	**48**	**51**	**99**

Source: High Accident Locations and Road Segments Analysis, July 2003.

7.2.3. Before/After Studies

Before/After Studies were completed for previous safety improvement projects at 25 HALs and 10 HARSs. The purpose of these studies was to assess the effect of the projects with respect to accident reduction and societal costs related to accidents. This information is useful in evaluating the HAL/HARS program, and to aid in selecting future safety improvements. Three years of "after" accident data were required for a location to qualify for a Before/After study, therefore the studies were limited to projects completed by December 1999. The findings are summarized in the following table.

TABLE 9 SUMMARY OF RESULTS - HAL/HARS BEFORE/AFTER STUDIES			
	HALs	HARSs	Both
Number of Afterstudies	25	10	35
Number w/ Lower Accident Rate	23	9	32
Number w/ Statistically Significant Reduction	19	9	28
Number w/ Higher Accident Rate	2	1	3
Average Reduction in Accident Rate	56%	64%	58%
Total Accidents Eliminated (Acc/yr)	66	63	129
Annual Reduction in Accident Costs[1]	$1,945,000	$1,736,000	$3,681,000
Number w/ Applicable Project Costs[2]	17	5	22
Average Project Cost	$180,206	$1,754,000	$537,886
Average Benefit/Cost Ratio	5.9	1.8	2.9
Annual Cost Savings[3]	$955,000	$404,000	$1,359,000

Source: Afterstudy Summary, 2003.

Notes
1. *The following costs per accident are used in this calculation: PDO-$6,000, Injury-$65,000, Fatality-$1,000,000*
2. *Excludes projects where a large portion of the cost would not address HAL/HARS issues (e.g. drainage, sidewalk, multi-intersection)*
3. *Reduction in accident costs minus annualized project cost.*

As indicated, the majority of the projects resulted in a reduction in the number of accidents. The 35 projects eliminated 129 accidents each year, and the estimated annual cost savings associated with the reduction in accidents is approximately $1,400,000.

The data was also broken down by improvement type so that the effect of different improvements could be assessed, and so that this information can be used when selecting future improvements. A breakdown by improvement type is provided in Table C9 (Appendix C).

7.3. <u>Traffic Signals</u>

When properly designed and operated, traffic signals are valuable devices for the control of vehicular and pedestrian traffic. Advantages of signals can include an increase in the capacity of intersections, a reduction in certain types of collisions (e.g. right-angle and left turn related collisions), and the ability to interrupt heavy traffic to allow access for vehicles or pedestrians on side streets.

However, signals are not a panacea for all traffic problems. Improper or unjustified signals can result in excessive delays, disobedience of signal indications; “cut-through” traffic on nearby roadways or through parking lots, and increases in the frequency of collisions (especially rear-end collisions).

For this reason, national standards are used to assess the need for signalization. These standards are referred to as signal warrants, and are contained in the Manual on Uniform Traffic Control Devices (MUTCD). There are eight signal warrants that are primarily related to vehicular traffic, but also include pedestrian use and collision data.

King County currently owns and operates 133 traffic signals. Annually, four to six new signals are constructed and three to eight existing signals are modified to provide operational and safety improvements. In 2003, six new traffic signals were constructed and four signals were modified.

7.3.1. New Installations

Traffic Engineering maintains a list of unsignalized intersections where signals are being considered, referred to as the Signal Priority Array. The Signal Priority Array includes locations meeting one or more of the MUTCD signal warrants as well as locations that are anticipated to meet signal warrants in the future. Locations are prioritized according to the signal warrants and their proximity to public schools.

New locations are added to the list at the request of citizens or staff, when significant development activity occurs in a specific area, or when new roadway connections are constructed. Traffic counts are collected and the signal warrants are reevaluated every 2 to 3 years for all locations on the list.

As of October 2004, there are 154 locations on the signal priority list. A total of 50 locations on the list meet one or more of the signal warrants. Twelve locations are currently funded for design and construction, and one is required for a development project.

There are several alternatives to signals, including roundabouts, construction of additional lanes, and realignment of road approaches, sight distance improvements, and restricting turning movements. In some cases, these alternatives may provide significant advantages when compared with signals. During preliminary design, locations on the signal priority array are evaluated for alternatives to signals, and a preferred alternative (not necessarily a signal) is selected.

7.3.2. Existing Signals

Improperly operated or poorly maintained signals can result in increased congestion or collision frequency. King County's traffic signals are monitored for maintenance and replacement needs, operational efficiency, and for signal upgrades such as protection for left-turn movements.

<u>Maintenance and Replacement</u>

Traffic Signal Technicians conduct preventative maintenance checks on all King County owned and operated signals every three months, and are on stand-by to respond all reports of irregularities. Annually, technicians check emergency vehicle equipment to ensure that all emergency vehicles can be detected as they approach the intersection and the traffic signal controller responds by providing a green indication for the approaching emergency vehicle. In addition, all incandescent signal indications and all luminaires at signalized intersections are replaced on an annual basis.

Priority lists for replacement of older signal equipment are currently under development.

<u>Operations and Upgrades</u>

As King County's population grows, existing signalized intersections can experience increases in congestion, delays and accident frequency.

Traffic counts and manual observations are used to evaluate signal operation, and signal phasing and timing is adjusted to optimize safety and traffic flow. Engineers and Technicians work cooperatively to ensure that each signal is operating efficiently and with minimal delay to all approaches. As areas become congested, this process is imperative to address driver frustration and minimize disobedience to signal displays.

The HAL/HARS program monitors locations for accident frequency and recommends improvements. Changes involving signals are then evaluated by the Signal Program, and implemented as appropriate.

The addition of left-turn signal phasing[14] can result in significant reductions in collisions when used at appropriate locations. For example, a before/after study indicated that the accident rate at the intersection of 116th Avenue SE and SE Petrovitsky Road decreased by 58% after left turn phasing was added. However, improper use of left turn phasing can also increase congestions and collisions, and therefore this improvement must be carefully evaluated. King County uses a formula know as the Left-Turn Product Warrant to evaluate left-turn phasing.

Another safety upgrade is the replacement of incandescent signal heads with light emitting diode (LED) signal heads. LED signal heads are more reliable, and improve safety by reducing signal down time. These signal heads also use approximately one-third of the energy, resulting in substantial cost savings. The County replaces incandescent signal heads when maintenance is required, and has requested funding for a countywide replacement program in 2005.

7.4. CIP Projects

Many of the Road Services Division's Capital Improvement Program (CIP) projects are directly related to safety. These include projects recommended to the CIP by the HAL/HARS program as well as projects to address locations where other potential safety issues have been identified. Most of the remaining CIP projects also have a safety component. For example, bridge replacement projects frequently include upgrades to guardrail and other safety improvements, while the primary purpose of these projects is usually infrastructure preservation.

Thirty-seven CIP projects were completed in 2003, while design continued on forty-eight additional projects.[15]

The ten arterials with the highest accident rates are listed previously in Table 5 (Section 6.3) of this report. Table 10 compares these arterials with CIP and other safety projects.

[14] Left turn signal phasing uses a "green arrow" signal head and provides a "protected" movement for left turning vehicles.
[15] The number of projects in design is based on information as of December 2003. Since that time, the CIP has been revised due to funding reductions, and a number of projects have been dropped.

TABLE 10 ARTERIAL ROADWAYS WITH HIGHEST ACCIDENT RATES COMPARISON WITH CIP PROJECTS			
Rank	**Roadway**	**CIP Project**	**Status**
1	S 120th St	300400	Completed 2002
2	SE 128th St	Traffic[1]	Completed 2002
3	S 118th St	Traffic[1]	Construction 2004
4	S 321 St	301200	Completed 2002
5	Military Rd S	Ped[2]	
6	34th Ave S	Ped[2]	
7	78th Ave S, S 112th St, 80th Ave S, Lkrdg Dr	Ped, Dev[2,3]	
8	148th Ave SE	Dev[3]	
9	17th Ave SW, 16th Ave SW, W/C Cutoff	None	
10	NE 80th St	None	
Notes	*1. Traffic Engineering Safety Improvement Project (non-CIP)* *2. Ped = Pedestrian Projects* *3. Dev = Developer Projects*		

As indicated in this table, no safety improvement projects are currently planned for two of the ten arterials. In addition, the pedestrian safety and developer projects planned for four of the arterials are unlikely to significantly reduce the accident rate.

Review of these six arterials for possible safety improvement projects is recommended in Section 8.

7.5. Traffic Signs

Properly designed and maintained traffic signs are a critical part of roadway safety. Conversely, inappropriate, excessively used, or poorly maintained signs can result in driver confusion, excessive delays, or increased collisions. For this reason, the Manual on Uniform Traffic Control Devices (MUTCD) establishes national standards for the design and placement of signs. The MUTCD also provides warrants, or criteria, for the installation of certain types of regulatory signs such as all-way stop signs.

To be effective, signs and other traffic control devices should fulfill a need, command attention, convey a clear simple meaning, command respect from road users, and give adequate time for proper response.[16] All proposed sign installations, removals, and relocations are designed by engineers from the Traffic Engineering Section, and are reviewed for compliance with MUTCD standards and generally accepted engineering practice.

[16] MUTCD, 2000

The Traffic Operations Unit is responsible for sign installation on arterial roadways, while the Neighborhood and Pedestrian Unit is responsible for non-arterials. During 2003, 800 sign-related work orders were issued.

KCDOT owns and maintains approximately 46,000 signs. Over time, signs lose their reflective properties from exposure to sunlight and dirt. In addition, they can be damaged due to collisions or vandalism. For this reason, Traffic Maintenance technicians inspect all signs on an annual basis. This includes a sign verification/night check to determine if signs are missing or if new signs that are not in the database have been installed. Signs are cleaned, repaired, and replaced as necessary based on the inspections and reflectivity testing.

The most recent update of the MUTCD establishes compliance dates by which agencies are expected to meet new standards for certain types of signs. In 2003, KCDOT began a corridor reconstruction program to evaluate all signs on arterials for MUTCD compliance.

7.6. Pedestrian Projects

Reported pedestrian collisions are infrequent, but receive special attention due to their severity. Pedestrian collisions comprised 1.4% of the accidents during 2003. A total of 39 collisions occurred, with an estimated cost of $3.4 million. 97% of these collisions resulted in injuries or fatalities.

Many jurisdictions rate pedestrian improvements along with other road projects. However, such systems are often biased towards motor vehicle improvements at the expense of pedestrian facilities. For this reason, KCDOT has a separate program that provides funding for pedestrian safety improvement projects.

The Pedestrian Pathway Prioritization (3P) Program, also referred to as the Pedestrian Safety and Mobility Program, designs and constructs improvements specifically for pedestrians and other non-motorized users. This program is managed by the Traffic Engineering Section, and funded through the CIP.

7.6.1. Prioritization

As with all transportation sectors, funding for pedestrian improvements is usually inadequate to satisfy all of the needs. For this reason, a priority process for pedestrian improvements has been established. The 3P rating process was first developed in 1990, and has since been revised to better reflect changes in design standards, County policy, land use, and public desires. The process consists of four components: Identification, Screening, Scoring, and Evaluation.

Initial identification of projects is provided by a number of different sources, including King County staff, citizens, businesses, community groups, and schools. Solicitation forms are distributed at community meetings, public hearings, and other public gatherings, or mailed directly to citizens known to have an interest in pedestrian safety. Press releases or public service announcements have shown to be very effective in generating responses.

Locations are field-checked and screened to eliminate those that are judged to be unjustified or infeasible. In some cases, projects are referred to other programs such as the School Pathway Program or the CIP. A preliminary scope of work and cost estimate is completed, and the projects then move on to the scoring phase.

Projects are scored based on traffic volumes, speed, land use, existing roadway conditions, collisions, and project cost. After projects are scored, those scoring the highest undergo final evaluation. The scores themselves may not account for certain considerations such as political and environmental feasibility. For this reason, some projects may need to be further scrutinized during this evaluation phase.

7.7. School Pathways

King County continues to focus on improving walking routes for elementary, middle, and high school students living in unincorporated areas. In many cases, the projects are small in scale, but the payoff is huge – making the walk to school safer for all kids.

The School Pathway Program is a collaborative effort between King County and the county's 16 public school districts and dozens of accredited private schools. Each district submits a list of potential pathway projects based on their prioritized needs. Projects are selected based on the priority rating given by the school district, and include factors such as cost, location, size and feasibility.

7.8. Safety Investigations

Traffic safety investigations include speed limit studies, no parking requests, sight distance concerns, requests for illumination, intersection operational improvements, installation of signing, traffic control and the installation of flashers. In most cases safety investigations are completed to respond to citizen requests or to provide information needed for road improvement projects.

The Traffic Operations Unit is responsible for safety investigations on arterial roadways. On non-arterials, the Neighborhood and Pedestrian Unit completes them. In most cases, these units are also responsible for completing any improvements recommended by the investigations.

During 2003, the Traffic Engineering Section completed approximately 640 traffic safety investigations.

7.9. Enforcement

Targeted enforcement can dramatically improve safety in problem areas by reducing speeding and other illegal driving behavior, and by educating motorists on safe driving practices.

The Selective Traffic Enforcement Plan (STEP) is a collaborative program bringing together the resources of two King County departments: the Sheriff's Office and the Department of Transportation. STEP deploys uniformed, motorcycle police officers on selected roadways in unincorporated King County. The program also provides radar reader board speed displays at selected locations.

Law enforcement and traffic engineers analyze current and historical data on accidents, traffic speeds, chronic traffic problems and citizen complaints to identify problem areas for STEP. During 2003, STEP officers issued over 2,600 warnings and 6,900 citations with a total of nearly $900,000 in fines.

Appendix D contains a copy of the STEP brochure that further describes the program, and the 2003 monthly summary reporting of hours spent, number of citizen contacts, number of warnings and citations issued and the revenue generated.

7.10. Neighborhood Traffic Safety

The Neighborhood Traffic Safety Program (NTSP), in cooperation with the Sheriff's Office to address growing concerns within the residential areas of unincorporated King County. This program offers a wide range of services to address the traffic safety concerns within those neighborhoods.

The number one concern of residents is vehicle speeds. There are several general reasons for speeding. Residents drive faster on their local streets because they feel familiar and comfortable. Outsiders use local streets as short cuts to busy arterial roads. Speeding increases the risk of collisions, and is of particular concern with respect to children and elderly people.

The NTSP provides a variety of tools to address speeding and cut-through traffic problems. The program has two traffic enforcement officers tasked with speed enforcement within the residential areas. The officers act both to deter speeders and to educate motorists on safe driving practices.

NTSP staff engineers hold neighborhood meetings to discuss the causes of speeding and approaches to reducing it. One tool that can be used as a result of the meetings is a sign with the message "Please drive Carefully, For Our Children's Sake, 25 mph". These signs are placed in neighborhoods after a pledge has been signed by the residents to obey the posted limit.

7.11. Collision Records

Traffic collision data is used regularly throughout Traffic Engineering, and is a primary source of information for this report, and for many Road Services programs, including the HALS/HARS, CIP, Signal, Guardrail, and Safety Investigation Programs. In addition, state law (WAC 308-330) requires local agencies to maintain collision records for at least the most current five years.

Traffic Engineering's Data Analysis Group maintains traffic collision records in database form dating back to January 1, 1984. The Washington State Patrol initially provided collision data. However, the State Patrol encountered technology problems while attempting to convert to a new data acquisition system, and has been unable to provide this data for collisions occurring after 1996. Due to the critical nature of this information, King County DOT's Data Analysis Group has completed data entry for collisions occurring between 1997 and 2003, and is in the process of entering 2004 collision data.

The Washington State Patrol is developing a Web based application to allow local agencies to automatically download collision data. However, this system is not yet operational. King County is developing an application to import the state data. However, this application is still in the development stages and is not anticipated to be operational until mid 2005.

8.0 RECOMMENDATIONS

One of the primary goals of this Annual Safety Report is to provide a mechanism to evaluate safety efforts and make recommendations to improve these efforts. The following recommendations are offered along with a discussion of the staffing and budget that would be required to implement them.

8.1. Roadside Objects

Run-off-road collisions were the most common accident type in 2003, and accounted for seven of the fourteen fatal accidents. Given the prevalence of this accident type, further attention is warranted.

Run-off-road collisions are further categorized according to the object encountered during the collision. Guardrails and other traffic barriers were the most frequently struck objects. Current practices address barrier collisions by upgrading older barrier systems to comply with new standards. Barrier systems are upgraded according to the guardrail retrofit priority list, and can also be upgraded when damaged.

Isolated fixed objects (utility poles, fences, trees, signs and mailboxes) were involved in nearly two-thirds of the run-off-road collisions. Utility poles were the mostly frequently struck isolated fixed objects. The countywide guardrail program addresses utility poles that have been struck more than two times in a ten-year period on a case-by-case basis, and other roadside objects using a corridor approach.

Given the number of utility pole collisions, adding a relocation requirement for the poles closest to the edge of the roadway should be seriously considered. King County is currently working with utility companies to revise the Utility Franchise Agreement, and discussion of such a requirement is recommended.

This recommendation would involve little additional effort since discussions are currently underway.

8.2. GIS Capability

The ability to review collision locations on a Geographical Information System (GIS) database could provide significant benefits. For example, contour or spot density maps would be useful in visually identifying problem areas, particularly with pedestrian and bicycle accidents. Other uses include comparing accident experience with other information that is currently available in King County's GIS database (e.g. CIP projects or guardrail locations).

The value of adding collision information to the GIS database has been recognized, and preliminary efforts have been made to accomplish this. The preliminary work has indicated that significant resources will probably be required, including a budget and possibly additional staffing. Efforts continue, however, it is unclear that these efforts will be sufficient to accomplish the task.

A review of the cost and staffing requirements to complete this project within a one-year time frame is recommended. The information obtained in this review could then be used to determine the feasibility of a GIS conversion.

8.3. Motorcycle Collisions

Although the change may be due to statistical fluctuation, motorcycle collisions have increased by 44% since 1999. In addition, nearly 90% of motorcycle collisions result in injuries or fatalities. Given this severity and the increase in the number of accidents, further effort may be warranted. These efforts could include public service announcements, additional enforcement, and discussion with State officials regarding licensing requirements and driver education. These items have moderate cost implications, but would be unlikely to require additional staffing.

8.4. Younger Drivers

Over one-third of the drivers involved in collisions during 2003 were between 16 and 24 years old. Education and outreach for younger drivers may be an appropriate area for additional focus.

The State of Washington recently initiated graduated licensing requirements for younger drivers. Additional efforts could include public service announcements, visits to local high schools, and discussion with State officials regarding licensing requirements and driver education. These items have moderate cost implications, but would be unlikely to require additional staffing.

8.5. "Top Ten" Arterials

The annual accident rate book provides accident rates for King County's arterial roadways. The ten roadways with the highest accident rates were reviewed for planned or recently completed improvement projects (see Table 10 in Section 7.4). On six of these roadways, no safety improvement projects are currently planned, or the planned projects are pedestrian or developer projects that are not expected to significantly reduce the accident rate.

Review of these six arterials for possible safety improvement projects is recommended. This recommendation would involve some staff effort but is not expected to require additional staffing or budget. Proposed improvements could be addressed within existing programs. For example, larger projects could be added to the CIP. In addition, it is recommended that the top ten arterials be reviewed on an annual basis and safety projects recommended where appropriate.

APPENDIX A

DATA SOURCES

Collision Data

Collision information was obtained from the Washington State Patrol Data Unit. The Washington State Patrol is responsible for maintaining all collision records in Washington State. Vehicular collisions which involve more than $500 damage to one party, or involve injury or death are required to be reported to the Washington State Patrol by a traffic collision report or a Police Traffic Collision Report.

Injuries are classified on the basis of conditions that occurred at the time of the collision, except in the case of fatalities. An injury resulting in a death within 30 days of the collision is classified as a fatal injury.

Population Data and Square Footage of King County

Population and square footage of Unincorporated King County is courtesy of King County's Office of Policy and Regional Planning as provided in an email dated August 4, 2004. 2002 population figures are from the Washington State Office of Finance.

King County Maintained Roadway Figures

King County's Maintenance Section, and The County Road Administration Board (CRAB) provided the number of miles of roadway King County maintains.

Traffic Count Data

King County's Traffic Engineering Section, Traffic Impact and Data Analysis Unit provided Traffic Count information used in this report.

Licensed Vehicles

Information on licensed vehicles was obtained from the Washington State Department of Licensing via email on July 30, 2004.

APPENDIX B

FORMULAS USED IN THIS REPORT

Accident Rate

The accident rate for a given roadway during a one-year time period is calculated using the following formula:

$R = (Acc * 10^6)/(ADT*365*L)$, where

R = accident rate in accidents per million vehicle mile (acc/mvm),
Acc = number of accidents in one year period,
ADT=average daily traffic volume, and
L=length of study section, in miles.

The accident rate for a street network during a one-year time period can be calculated using the following formula:

R = Acc/AMD, where AMD = annual miles driven in million vehicle miles.

AMD is calculated using:

AMD= WADT*365*RM, where

WADT= weighted average daily traffic for the street network, calculated by $WADT = (\Sigma ADT*L)/ \Sigma L$, and
RM = road miles for the street network (in million miles).

Traffic volumes for the local streets are not available. Therefore it is necessary to estimate the AMD using arterial volumes. To compensate for the lower volumes on local streets, the result was divided by two. This results in the following formula:

AMD(estimated) = WADT*365*RM/2.

Since the AMD is estimated, the accident rate for King County roadways is also an estimate. This estimate is useful in comparing historic rates on county roadways, but would be not be appropriate to compare with accident rates for other jurisdictions.

Societal Costs of Collisions

The cost of collisions were calculated using the following formula:

Cost = $6,000*PDO + $65,000*I + $1,000,000*F, where

PDO = Property Damage Only collisions
I = collisions with one or more injuries, and
F = collisions with one or more fatalities.

Percentage Increase/Decrease

The percentage increase between two measurements made at different times is calculated using the following equation:

Increase (%) = (y-x)/100x, where x = the earlier value and y = the later value

The percentage decrease between two measurements made at different times is calculated using the following equation:

Decrease (%) = (x-y)/100x, where x = the earlier value and y = the later value

Note that result of subtracting the two values is divided by the earlier value for both increases and decreases. These results are not interchangeable: an increase from 50 to 100 is a 100% increase, while a decrease from 100 to 50 is a 50% decrease.

APPENDIX C

ADDITIONAL TABLES & FIGURES

TABLE C1
2002 & 2003 COLLISIONS BY TYPE AND SEVERITY

	2003					2002					
Collision Type	**Property Damage Only**	**Injury**	**Fatalities**	**Total**	**Societal Cost (millions)**	**Property Damage Only**	**Injury**	**Fatalities**	**Total**	**Societal Cost (millions)**	**Change in Total Collisions**
Run-Off-Road	430	192	7	**629**	**$22.1**	382	200	6	**588**	**$21.3**	**6.97%**
Rear End	360	217	0	**577**	**$16.3**	345	232	1	**578**	**$18.2**	**-0.17%**
Right Angle	281	174	1	**456**	**$14.0**	292	179	0	**471**	**$13.4**	**-3.18%**
Left Turn	122	87	1	**210**	**$7.4**	126	95	1	**222**	**$7.9**	**-5.41%**
Parked Car	217	18	1	**236**	**$3.5**	202	19	1	**222**	**$3.4**	**6.31%**
Sideswipe	115	42	0	**157**	**$3.4**	63	26	0	**89**	**$2.1**	**76.40%**
Rollover	63	93	2	**158**	**$8.4**	41	80	4	**125**	**$9.4**	**26.40%**
Head On	26	41	1	**68**	**$3.8**	7	23	1	**31**	**$2.5**	**119.35%**
Right Turn	2	1	0	**3**	**$0.1**	4	7	0	**11**	**$0.5**	**-72.73%**
Pedestrian	1	37	1	**39**	**$3.4**	0	38	1	**39**	**$3.5**	**0.00%**
Bicycle	3	23	0	**26**	**$1.5**	1	34	0	**35**	**$2.2**	**-25.71%**
Other	87	46	0	**133**	**$3.5**	108	49	1	**158**	**$4.8**	**-15.82%**
Total	**1707**	**971**	**14**	**2692**		**1571**	**982**	**16**	**2569**		**4.79%**
Societal Cost (millions)	**$10.2**	**$63.1**	**$14.0**	**$87.4**		**$9.4**	**$63.8**	**$16.0**	**$89.3**		**-2.13%**

The following estimated costs per accident are used in this table: PDO-$6,000, Injury-$65,000, Fatality-$1,000,000

TABLE C2
2002 & 2003 RUN-OFF-ROAD COLLISIONS BY OBJECT STRUCK AND SEVERITY

	2003				2002				
Object Struck	**Property Damage Only**	**Injury**	**Fatalities**	**Total**	**Property Damage Only**	**Injury**	**Fatalities**	**Total**	**Change in Total Collisions**
Water/ Embankment	51	34	1	**86**	62	54	1	**117**	**-26.50%**
Utility Pole	64	51	0	**115**	50	50	0	**100**	**15.00%**
Tree or Stump	53	32	1	**86**	46	31	2	**79**	**8.86%**
Fence	80	27	2	**109**	77	21	0	**98**	**11.22%**
Barrier/Guardrail	96	35	3	**134**	77	29	2	**108**	**24.07%**
Mail Box	44	2	0	**46**	33	8	0	**41**	**12.20%**
Sign	38	8	0	**46**	34	6	1	**41**	**12.20%**
Misc/Unidentified	4	3	0	**7**	3	1	0	**4**	**75.00%**
Total	**430**	**192**	**7**	**629**	**382**	**200**	**6**	**588**	**6.97%**

TABLE C3
10-YEAR TRAFFIC VOLUMES, ROAD MILES, AND ACCIDENT RATES

		Average Daily Traffic Volumes (ADT)[1]		Maintained Road Miles			Annual Miles Driven (million miles)[3]			Estimated Accident Rate (All County Roads)[5]
Year	Total Collisions	Principle Arterials	All Arterials	Principle Arterials[1]	All Arterials[1]	All County Roads[2]	Principle Arterials	All Arterials	All County Roads[4]	
1994	4526	11,717	7,595	128	785	2,361	546	2,177	3,273	**1.38**
1995	4136	12,353	6,654	119	513	2,207	538	1,247	2,680	**1.54**
1996	3747	NA	NA	NA	NA	2,169	NA	NA	NA	**NA**
1997	3032	12,849	6,786	119	483	2,048	558	1,196	2,536	**1.20**
1998	2873	NA	NA	NA	NA	1,994	NA	NA	NA	**NA**
1999	2631	12,575	6,849	97	445	1,906	445	1,112	2,382	**1.10**
2000	2433	13,278	6,781	90	437	1,849	434	1,082	2,288	**1.06**
2001	2416	NA	NA	NA	NA	1,832	NA	NA	NA	**NA**
2002	2569	13,441	6,635	88	439	1,895	430	1,062	2,295	**1.12**
2003	2692	13,231	6,531	88	439	1,883	423	1,045	2,244	**1.20**
Change (1994-2003)		**13%**	**-14%**	**-31%**	**-44%**	**-20%**	**-23%**	**-52%**	**-31%**	**-13%**

Data Sources:

1. *Accident Rates for Arterial Roadways, 1994-2003 (Traffic Engineering)*
2. *Road Log Approval Letters, 1994-2003 (CRAB)*
3. *Calculated by multiplying ADT * 365 * maintained road miles*
4. *Estimated value. The average ADT for all arterials used in calculation since ADT is not available for all roadways. The result is divided by two to compensate for lower volumes on local access roadways.*
5. *Calculated by dividing total collisons by annual miles driven. Results in accidents per million vehicle miles.*

TABLE C4
2003 PEDESTRIAN COLLISIONS BY FACILITY AND AGE

Age	Marked Cross Walk	UnMarked Cross Walk	Sidewalk	Shoulder	Roadway	Other	Total
1-4	1	0	1	0	0	0	2
5-9	0	0	0	0	1	0	1
10-14	2	0	0	0	0	1	3
15-19	0	0	0	3	3	1	7
20-24	0	0	0	0	0	0	0
25-44	2	0	0	3	2	2	9
45-64	5	1	2	1	4	1	14
65 and Older	1	0	0	1	1	0	3
Total	**11**	**1**	**3**	**8**	**11**	**5**	**39**

TABLE C5
2002 PEDESTRIAN COLLISIONS BY FACILITY AND AGE

Age	Marked Cross Walk	UnMarked Cross Walk	Sidewalk	Shoulder	Roadway	Other	Total
1-4	0	0	1	1	0	0	**2**
5-9	0	0	0	0	3	0	**3**
10-14	1	0	0	0	3	1	**5**
15-19	3	0	0	0	1	1	**5**
20-24	1	0	0	0	1	2	**4**
25-44	6	0	0	1	3	0	**10**
45-64	2	1	1	0	5	1	**10**
65 and Older	0	0	0	0	0	0	**0**
Total	**13**	**1**	**2**	**2**	**16**	**5**	**39**

TABLE C6 1994-2003 PEDESTRIAN COLLISIONS BY FACILITY AND AGE								
Age	**Marked Cross Walk**	**UnMarked Cross Walk**	**Sidewalk**	**Shoulder**	**Designated Bike Route**	**Roadway**	**Other**	**Total**
1-4	4	0	2	1	0	1	21	**29**
5-9	5	1	0	0	0	6	28	**40**
10-14	28	0	0	0	2	3	50	**83**
15-19	22	0	1	5	0	6	51	**85**
20-24	12	1	2	1	2	3	18	**39**
25-44	27	2	9	10	0	8	45	**101**
45-64	19	5	6	2	2	10	30	**74**
65 and Older	6	0	0	2	3	2	11	**24**
Total	**123**	**9**	**20**	**21**	**9**	**39**	**254**	**475**

TABLE C7 BICYCLE COLLISIONS BY AGE AND YEAR			
Age	**2003**	**2002**	**1994-2003**
1-4	2	0	21
5-9	4	2	60
10-14	4	16	142
15-19	1	5	67
20-24	3	0	24
25-44	10	4	87
45-64	2	8	33
65 and Older	0	0	2
Total	**26**	**35**	**436**

TABLE C8
ACCIDENTS BY COLLISION TYPE AND ROADWAY

Collision Type	Intersection[1]	Non-Intersection: Driveway Related	Non-Intersection: Not Driveway Related	Roadway Alignment: Tangent and Level	Roadway Alignment: Level with Horizontal Curve	Roadway Alignment: Tangent with Vertical Grade[2]	Roadway Alignment: Curve and Grade	Roadway Alignment: Unidentified
Run-Off-Road	161	5	463	232	127	104	157	9
Rear End	331	1	245	349	14	170	34	10
Right Angle	333	35	88	286	15	127	22	6
Left Turn	160	0	50	123	2	73	11	1
Rollover	21	1	136	37	38	27	55	1
Parked Car	26	19	191	130	23	53	22	8
Sideswipe	48	2	107	62	21	43	28	3
Head On	23	0	45	18	9	13	27	1
Right Turn	2	1	0	2	0	1	0	0
Pedestrian	14	2	23	23	2	11	3	0
Bicycle	15	1	10	13	1	8	4	0
Other	52	1	80	63	9	44	17	0
Total	**1186**	**68**	**1438**	**1338**	**261**	**674**	**380**	**39**

Notes
1. Includes intersection-related collisions that are not at intersection
2. Includes Sag and Crest Verticle Curves

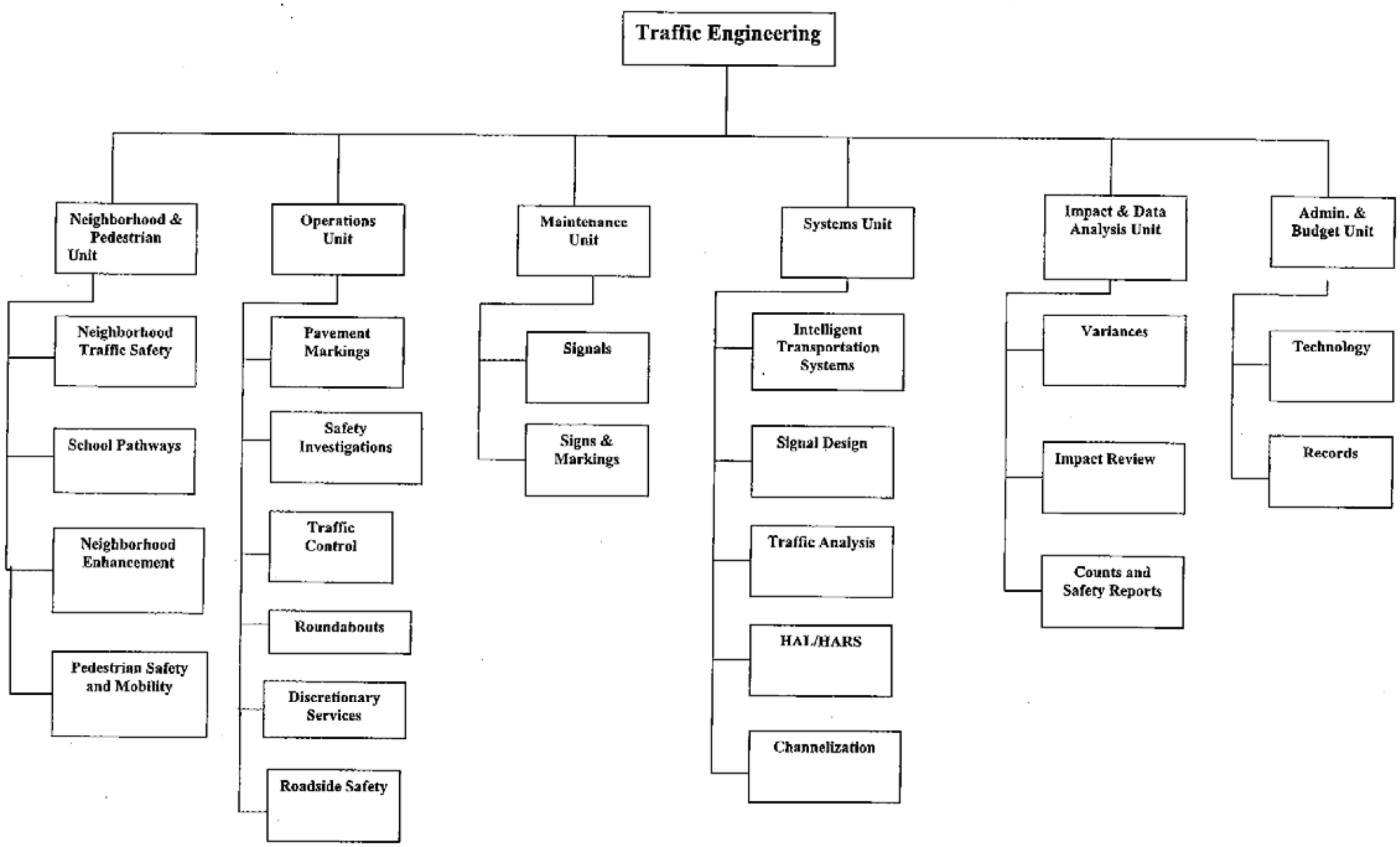
TABLE C9
HAL/HARS Before/After Studies - Breakdown by Improvement Type

Improvement Type	No. Projects	Number w/ Statistically Significant Reduction1	Average Reduction Factor2	Expected Reduction Factor3	Average Annual Reduction in Accident Costs4	Average Project Cost	Average Benefit/Cost Ratio	Average Annual Cost Savings5	Comments
All Way Stop	3	2	42%	55%	$15,500	$9,000	56	$30,000	Cost figures do not include HAL 61 to avoid skewing of data caused by fatality.
Channelization	2	2	61%	25%	$115,000	$42,000	24	$110,000	
LT Lanes	3	3	71%	30%	$78,000	$500	1060	$59,000	Only one project cost available to calculate average project cost, B/C Ratio, and Cost Savings.
LT Lanes w/ Roadway Reconfiguration	2	2	81%	60%	$196,000	NA	NA	NA	
LT Lanes w/ Sight Distance Improv.	1	0	25%	50%	$26,000	NA	NA	NA	
LT Lanes- Total	**6**	**5**	**67%**		**$108,667**	**$500**	**$1,060**	**$59,000**	Only one project cost available to calculate average project cost, B/C Ratio, and Cost Savings.
Roadway Reconfiguration	1	1	63%	40%	$101,000	$63,000	14	$94,000	
New Signal	2	1	57%	25%	$67,000	$126,000	7	$60,000	
New Signal w/ LT Lanes	7	5	62%	45%	$83,000	$628,000	6.1	$115,000	
New Signal w/ Roadway Reconfiguration	1	1	56%	55%	$56,000	NA	NA	NA	
Signal LT Phasing	4	3	66%	40-70%	$141,500	$35,000	97	$206,000	
Signal Coordination	2	2	67%	15%	$295,000	NA	NA	NA	
Signals - Total	**16**	**12**	**68%**		**$112,063**	**$299,250**	**28**	**$109,313**	
Widening	6	5	58%	25%	$143,000	$1,900,000	1.8	$94,000	
Warning Signs	1	0	18%	25%	$4,000	$500	72	$3,900	

Source: Afterstudy Summary, 2003.

Notes: 1. *Based on methodology recommended in National Cooperative Research Program (NCHRP) Report 162 using 90% confidence level.*
2. *Percentage reduction in all accident types except where noted.*
3. *Agent, Stamatiadis, and Jones, Development of Reduction Factors, University of Kentucky, 1996.*
4. *The following costs per accident are used in this calculation: PDO-$6,000, Injury-$65,000, Fatality-$1,000,001*
5. *Reduction in accident costs minus annualized project cost.*

FIGURE C1: TRAFFIC ENGINEERING ORGANIZATIONAL CHART



APPENDIX D

STEP PROGRAM INFORMATION

REC'D KING COUNTY TRAFFIC ENGINEERING
04 FEB -2 PM 1:09

SHERIFF
KING COUNTY

Memorandum

Date: January 24, 2004
To: [redacted] **Via:** Direct [redacted]
From: [redacted]
Re: **2003 ANNUAL STEP SITE SUMMARY REPORT**

The following is a recap of the semi-monthly S.T.E.P. site summary reports for calendar year 2003:

Months:	Hours:	Contacts:	Warnings:	Citations:	Revenue:
Jan/Feb	367	1,223	423	800	$ 86,371
Mar/Apr	242	824	241	583	$ 60,599
May/June	600	2,317	624	1,693	$194,677
July/Aug	350	1,661	376	1,285	$165,112
Sept/Oct	455	2,047	608	1,439	$218,118
Nov/Dec	376	1,447	331	1,116	$170,466
Totals:	**2,390**	**9,519**	**2,603**	**6,916**	**$896,343**
		(3.99/hr)	(27.35%)	(72.65%)	($375/hr)

S.T.E.P. carried 2 vacancies from January through April, then 1 vacancy from May through October. That equates to 1 FTE for 14 months. I was however able to backfill with 2 SWAT motors from January through June, or 1 FTE for 12 months. STEP is fully staffed starting out 2004, and with the return of the two SWAT motors from their temporary duty assignment, I am able to resume utilizing them for STEP site enforcement.

Collectively for 2003, there were **8,534 citations** issued which generated almost **1.2 million dollars.**

- NTSP accounted for 1,208 of those citations, (14.16%), and contributed $193,425 in revenue, (16.36%). *2 Officers, no vacancies but 1 two month disability leave.*
- SWAT accounted for 976 of those citations, (11.43%), and contributed $90,105 in revenue, (7.62). *2 Deputies, deployed only 6 months to traffic in 2003.*
- STEP accounted for the remaining 6,350 citations, (74.41%), and contributed $898,641 in revenue, (76.02%). *7 Deputies; carried 2 vacancies for 4 months, 1 vacancy for 6 more months.*
- Actual STEP site enforcement accounted for 6,916 of the 7,326 citations issued, (94.40%), and $896,343 of the $988,746 revenue generated, (90.65%). The remaining citations/revenue is incidental traffic enforcement not tracked to a specific STEP site.

Page 1 of 1

Most people know how to use our streets safely, but can get careless when in a hurry. STEP officers provide a highly visible presence and a reminder that no one is too busy to practice safe driving, walking and bicycling habits.

STEP is just one way King County is responding to traffic safety problems in unincorporated King County. By raising driver awareness, STEP officers help improve the quality of life for all of us.

Want to learn more?

For more information about traffic safety, Radar Readerboards or Block Watch programs in your neighborhood, contact the King County Sheriff's Office precinct or closest storefront to you:

Precinct 2, Kenmore	(206) 296-5020
Precinct 3, Maple Valley	(206) 296-3883
Precinct 4, Burien	(206) 296-3333

To request traffic enforcement on your street, contact the King County Sheriff's Office, (206) 296-3311, 24 hours a day, 7 days a week.

To report damaged road signs, vegetation that needs pruning or potholes in your street, contact King County Road Services Maintenance, (206) 296-8100, or 1-800-KC-ROADS (toll-free), 24 hours a day, 7 days a week.

To report traffic concerns in your neighborhood or to learn more about the Neighborhood Traffic Safety Program, contact King County Traffic Engineering, (206) 296-6596, 8 a.m. - 5 p.m. weekdays.

King County Department of Transportation
Road Services Division, Traffic Engineering
201 S. Jackson Street, KSC-TR-0313
Seattle, WA 98104-3856
(206) 296-6596

This brochure is available in accessible formats for people with disabilities. Call (206) 684-1162 (voice) or (206) 684-1682 (TTY).

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STEP
Selective **T**raffic **E**nforcement **P**lan

King County Sheriff's Office and Department of Transportation

*STEP*ping Up Traffic Safety
in Unincorporated Neighborhoods

King County Department of Transportation ROAD SERVICES

SHERIFF KING COUNTY

Mobility for the Region

*STEP*ping Up Traffic Safety in Unincorporated Neighborhoods

The STEP squad is one way King County is improving traffic safety in King County neighborhoods.

How STEP works

STEP, or ***S**elective **T**raffic **E**nforcement **P**lan*, is an expansion of the Neighborhood Traffic Safety Program to unincorporated King County arterials. STEP is a collaborative program bringing together the resources of two King County departments: the Sheriff's Office and the Department of Transportation.

STEP places uniformed, motorcycle police officers on selected arterial roads in unincorporated King County. Law enforcement and traffic engineers have analyzed historical data on accidents, traffic speeds, chronic traffic problems and citizen complaints and identified a number of long-standing problem areas as candidates for STEP services.

How STEP can make a difference

STEP is intended to promote traffic safety by raising drivers' awareness of safe driving habits. One of the officers' primary objectives is to change the behavior of drivers who don't obey speed limits.

Many drivers don't realize speeding doesn't significantly reduce total commuting time.

STEP officers will increase public awareness by providing education, traffic information, Radar Readerboard speed displays, verbal warnings and, as appropriate, traffic citations. Just the presence of these highly visible officers sends a strong signal that speeding and unsafe driving are unacceptable and have consequences.

As drivers reduce their vehicle speeds, traffic analysts expect communities to experience fewer traffic-related accidents, injuries and property damage.

STEP officers will focus on the problems created by drivers who exceed speed limits – after all, speeding is a contributing factor in traffic-related deaths. The STEP officers will also remind drivers and pedestrians that:

- Pedestrians always have the right-of-way in crosswalks – drivers must yield.
- Drivers need to be as respectful of speed limits in other neighborhoods as they want drivers in their own neighborhoods to be.
- Studies show that speeding makes little difference in total commute time.
- High speeds reduce the ability to successfully cope with the unexpected.
- Children are the most common pedestrians on residential streets and most likely to be the victims of careless driving.
- A pedestrian has an 85 percent chance of being killed in a collision with a car traveling at 40 mph.

STEP officers help educate neighborhood residents, including children, about traffic safety.